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# RESOURCE AREA

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environmental  
assessment

BUREAU OF LAND MANAGEMENT  
CASPER DISTRICT, WYOMING  
1980





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BUFFALO RESOURCE AREA OIL AND GAS ENVIRONMENTAL ASSESSMENT

Bureau of Land Management

Casper District, Wyoming

June 1980

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## United States Department of the Interior

### BUREAU OF LAND MANAGEMENT

District Office  
951 Union Boulevard  
Casper, Wyoming 82601

IN REPLY REFER TO

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Dear Reader,

Enclosed is the environmental assessment for oil and gas activity in Campbell, Johnson, and Sheridan counties, Wyoming. The area analyzed includes over 6 million acres of federal, state, and private land, possessing diverse natural characteristics and land uses. We could not have prepared a document of this scope without the contributions of many people outside the Bureau of Land Management. I would like to take this opportunity to thank those of you who helped determine the important issues to be discussed in this

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## CHAPTER 1 PURPOSE AND ALTERNATIVES

### INTRODUCTION

The National Environmental Policy Act (NEPA) of 1969 requires that all programs and activities authorized by the Bureau of Land Management (BLM) be analyzed for probable environmental impacts. The leasing of federally controlled oil and gas is a major BLM program in Wyoming. Activities stemming from federal leasing, such as exploration and production, affect the quality of the human environment, and therefore must be assessed.

This environmental assessment (EA) describes the current and probable future impacts of oil and gas activity in the Buffalo Resource Area of BLM (Figure 1-1) until 1990. An important function of the EA is to provide management guidance, so that BLM can make better decisions about the resources it manages. In particular, this EA identifies areas considered suitable, as well as unsuitable, for future leasing; areas suitable for leasing only with special provisions; and mitigating measures which could be used to prevent or reduce damage to the environment.

Although BLM issues leases for federally controlled oil and gas throughout the resource area, the Forest Service makes the decisions about whether leasing should be allowed, and with what restrictions, on the lands it manages--the Bighorn National Forest and the Thunder Basin National Grasslands. BLM abides by these decisions when issuing leases. Forest Service leasing alternatives and environmental impact analysis are given in Environmental Assessment: Oil and Gas Leasing of National Forest System Lands in the Rocky Mountain Region (1979).

This document then, pertains to lands outside Forest Service jurisdiction, where BLM is responsible for leasing decisions and resulting surface disturbance.



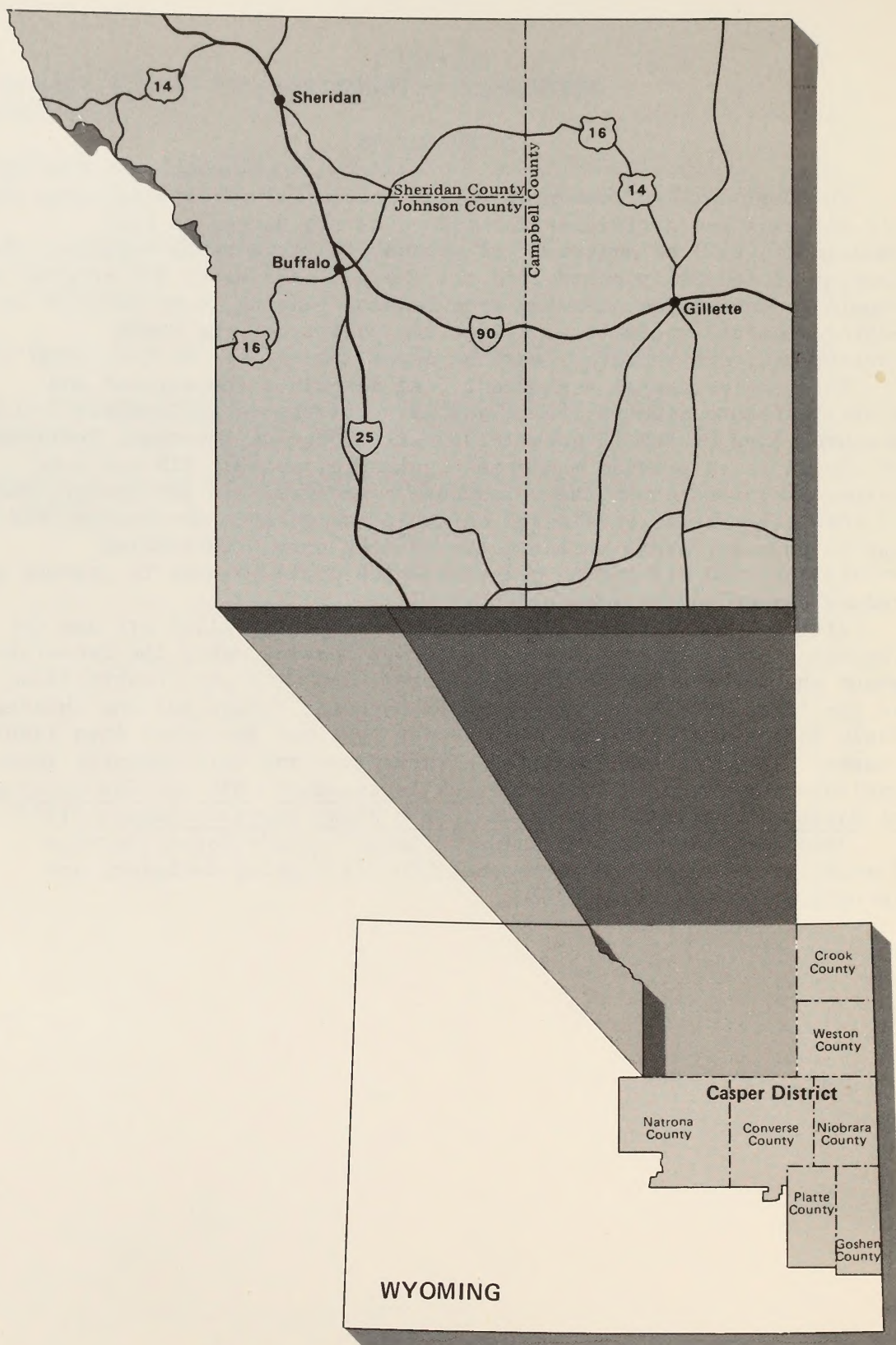


Figure 1 - 1  
Buffalo Resource Area

## PURPOSE

The purpose of leasing federal oil and gas is to permit the orderly development of mineral resources under federal jurisdiction and thereby provide energy fuels to help meet national demand.

## Background

The Buffalo Resource Area contains over 7 million acres in Campell, Johnson, and Sheridan counties, Wyoming. The major portion of the land surface is privately owned; in many cases, however, the mineral rights under private surface have been reserved to the federal government. The distribution of land ownership and the oil and gas estate is shown in Tables 1-1 through 1-3. All of the federal oil and gas estate beneath private, federal, or state surface is subject to lease, unless restrictions have been applied.

Important geographic features of the resource area are the Big Horn Mountains on the west, and the plains of the central and eastern portions, which are part of the Powder River Basin. The major drainage is the Powder River system.

Traditionally, the resource area has been ranching country. Since the 1940s, however, the mineral development and service industries have grown and overtaken agriculture in economic importance. The largest communities in the area are Gillette, Sheridan, and Buffalo; total population for the three counties in 1978 was 55,000 (U.S. Department of the Interior, Bureau of Land Management, 1979).

## Oil and Gas Development

Production of commercial oil resources in Campbell County began in 1948 at Adon Field north of Gillette. During the 1950s, 8 new fields were discovered, but major exploration activity in Wyoming was centered in Weston, Crook, and Niobrara counties. Beginning in 1960 there was a sharp increase in exploration in Campbell County, and between 1960 and 1971, 89 new fields were discovered, the most important of which are probably Gas Draw and Hilight. The oil boom in the county peaked in 1969 when 758 new wells were drilled, resulting in 413 producers and 18 new field discoveries (Petroleum Information 1970). Since 1970, drilling activity has leveled off to an average annual rate of 278 wells (see Table 1-4 and Figure 1-2). There are currently 150 producing fields in Campbell County (Barlow and Hawn 1978).

The first oil field discovery in Johnson County was near Sussex in 1948. Peak years for exploration and discovery were 1974 and 1975 when a total of 8 new fields were found. The number of currently producing fields is 27.

The first oil field discovery in Sheridan County occurred in 1952. There is little oil and gas activity within Sheridan County as compared to the rest of the Buffalo Resource Area. There are currently only 2 producing fields with a total of 15 wells.



TABLE 1-1

SURFACE OWNERSHIP DISTRIBUTION  
(Area in Acres)

|                 | <u>Total<br/>Surface Area</u> | <u>Private<br/>Ownership</u> | <u>% of<br/>Total</u> | <u>Federal<br/>Ownership</u> | <u>% of<br/>Total</u> | <u>State and<br/>Local Ownership</u> | <u>% of<br/>Total</u> |
|-----------------|-------------------------------|------------------------------|-----------------------|------------------------------|-----------------------|--------------------------------------|-----------------------|
| Campbell County | 3,058,308                     | 2,424,966                    | 79.3                  | 396,193                      | 12.9                  | 237,149                              | 7.8                   |
| Johnson County  | 2,662,597                     | 1,613,226                    | 60.6                  | 838,926                      | 31.5                  | 210,445                              | 7.9                   |
| Sheridan County | <u>1,613,604</u>              | <u>936,284</u>               | <u>58.0</u>           | <u>449,924</u>               | <u>27.9</u>           | <u>227,396</u>                       | <u>14.1</u>           |
| TOTAL           | 7,334,509                     | 4,974,476                    | 67.8                  | 1,685,043                    | 23.0                  | 674,990                              | 9.2                   |

Source: Bureau of Land Management, Wyoming State Office, Records and Data Management 1977.

TABLE 1-2

DISTRIBUTION OF FEDERAL SURFACE OWNERSHIP  
(Area in Acres)

|                 | <u>Total<br/>Surface Area</u> | <u>Bureau of<br/>Land Management</u> | <u>% of<br/>Total</u> | <u>Forest Service</u> | <u>% of<br/>Total</u> | <u>Other*</u> | <u>% of<br/>Total</u> |
|-----------------|-------------------------------|--------------------------------------|-----------------------|-----------------------|-----------------------|---------------|-----------------------|
| Campbell County | 3,058,308                     | 236,067                              | 7.7                   | 157,094**             | 5.1                   | 3,032         | 0.1                   |
| Johnson County  | 2,662,597                     | 512,051                              | 19.2                  | 326,875***            | 12.3                  | 0             | 0.0                   |
| Sheridan County | <u>1,613,604</u>              | <u>50,730</u>                        | <u>3.1</u>            | <u>394,481***</u>     | <u>24.4</u>           | <u>4,713</u>  | <u>0.3</u>            |
| TOTAL           | 7,334,509                     | 798,848                              | 10.9                  | 878,450               | 12.0                  | 7,745         | 0.1                   |

Source: Bureau of Land Management, Wyoming State Office, Records and Data Management 1977.

\* Includes Bureau of Reclamation, U.S. Fish and Wildlife Service, Veterans Administration, and U. S. Army.

\*\* Thunder Basin National Grasslands.

\*\*\* Bighorn National Forest.



TABLE 1-3

DISTRIBUTION OF OIL AND GAS ESTATE  
(Area in Acres)

|                 | <u>Total Acreage</u> | <u>Federal Oil<br/>and Gas Estate*</u> | <u>% of Total</u> | <u>State or Private<br/>Oil and Gas Estate</u> | <u>% of Total</u> |
|-----------------|----------------------|----------------------------------------|-------------------|------------------------------------------------|-------------------|
| Campbell County | 3,058,308            | 1,837,354                              | 60                | 1,220,954                                      | 40                |
| Johnson County  | 2,662,597            | 928,664                                | 35                | 1,733,933                                      | 65                |
| Sheridan County | <u>1,613,604</u>     | <u>282,220</u>                         | <u>17</u>         | <u>1,331,384</u>                               | <u>83</u>         |
| TOTAL           | 7,334,509            | 3,048,238                              | 42                | 4,286,271                                      | 58                |

---

Source: Bureau of Land Management, Wyoming State Office, Records and Data Management 1977.

\* Includes reservation categories all minerals, oil and gas, and oil and gas and miscellaneous.

TABLE 1-4

ANNUAL WELL COMPLETIONS  
(All Ownership)

|                 | <u>All Wells<br/>Drilled</u> | <u>Wildcats*</u>   | <u>Dry Holes</u>   |
|-----------------|------------------------------|--------------------|--------------------|
| <u>1970</u>     |                              |                    |                    |
| Campbell County | 713                          | 155                | 304                |
| Johnson County  | 11                           | 4                  | 5                  |
| Sheridan County | 13                           | 10                 | 11                 |
| TOTAL           | <u>737</u>                   | <u>169</u> (23%)** | <u>320</u> (43%)** |
| <u>1971</u>     |                              |                    |                    |
| Campbell County | 284                          | 70                 | 139                |
| Johnson County  | 9                            | 1                  | 3                  |
| Sheridan County | 12                           | 6                  | 11                 |
| TOTAL           | <u>305</u>                   | <u>77</u> (25%)    | <u>153</u> (50%)   |
| <u>1972</u>     |                              |                    |                    |
| Campbell County | 341                          | 109                | 215                |
| Johnson County  | 21                           | 11                 | 14                 |
| Sheridan County | 9                            | 7                  | 9                  |
| TOTAL           | <u>371</u>                   | <u>127</u> (34%)   | <u>238</u> (64%)   |
| <u>1973</u>     |                              |                    |                    |
| Campbell County | 211                          | 91                 | 144                |
| Johnson County  | 23                           | 12                 | 12                 |
| Sheridan County | 4                            | 3                  | 4                  |
| TOTAL           | <u>238</u>                   | <u>106</u> (45%)   | <u>160</u> (67%)   |
| <u>1974</u>     |                              |                    |                    |
| Campbell County | 228                          | 100                | 135                |
| Johnson County  | 34                           | 28                 | 25                 |
| Sheridan County | 14                           | 14                 | 14                 |
| TOTAL           | <u>276</u>                   | <u>142</u> (51%)   | <u>174</u> (63%)   |
| <u>1975</u>     |                              |                    |                    |
| Campbell County | 305                          | 96                 | 159                |
| Johnson County  | 61                           | 31                 | 35                 |
| Sheridan County | 9                            | 7                  | 9                  |
| TOTAL           | <u>375</u>                   | <u>134</u> (36%)   | <u>203</u> (54%)   |



TABLE 1-4  
(cont'd)

ANNUAL WELL COMPLETIONS  
(All Ownership)

|                 | <u>All Wells<br/>Drilled</u> | <u>Wildcats*</u> | <u>Dry Holes</u> |
|-----------------|------------------------------|------------------|------------------|
| <u>1976</u>     |                              |                  |                  |
| Campbell County | 242                          | 68               | 117              |
| Johnson County  | 69                           | 34               | 39               |
| Sheridan County | <u>4</u>                     | <u>4</u>         | <u>4</u>         |
| TOTAL           | 315                          | 106 (34%)        | 160 (50%)        |
| <u>1977</u>     |                              |                  |                  |
| Campbell County | 334                          | 75               | 140              |
| Johnson County  | 60                           | 26               | 31               |
| Sheridan County | <u>4</u>                     | <u>3</u>         | <u>4</u>         |
| TOTAL           | 398                          | 104 (26%)        | 175 (44%)        |
| <u>1978</u>     |                              |                  |                  |
| Campbell County | 277                          | 95               | 156              |
| Johnson County  | 76                           | 33               | 43               |
| Sheridan County | <u>3</u>                     | <u>1</u>         | <u>2</u>         |
| TOTAL           | 356                          | 129 (36%)        | 201 (56%)        |

---

Source: Petroleum Information Corporation, 1971 through 1979.

\* Wells drilled outside producing fields.

\*\* Percent of total wells drilled.

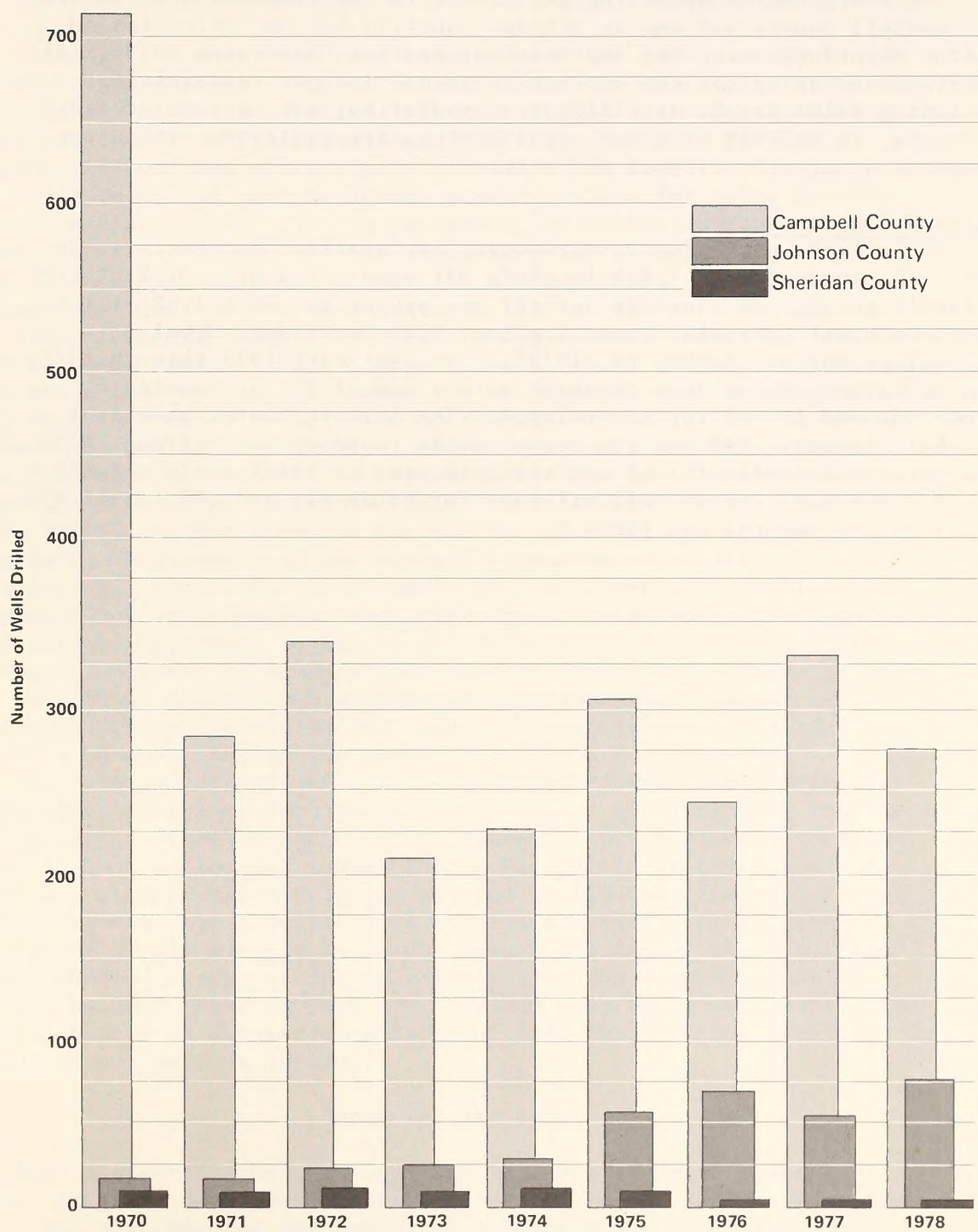


Figure 1 - 2  
Annual Well Completions



There are twelve operating gas plants in the resource area (eleven in Campbell County and one in Johnson County), but no refineries or sulfur plants (Wyoming Oil and Gas Conservation Commission 1979). All services necessary for the extraction of oil and gas resources, including seismograph, drilling, transportation, and well maintenance services, as well as dirt work contracting, are available within the resource area, primarily at Gillette.

#### Oil and Gas Production

The oil and gas industry in Wyoming is important nationally. In 1977, the state ranked fifth in crude oil production with 3.7% of the nation's total, and sixth in natural gas production with 1.6% of the nation's total (personal communication, Alan Ver Ploeg, Wyoming Geological Survey, August 15, 1979). For the years 1973 through 1978, the Buffalo Resource Area produced an average of 27% of Wyoming's crude oil and 16% of its natural gas. The largest shares come from Campbell County: 24% and 13% respectively (Goodier and Hoffman 1979). The percent contribution of the resource area to total state valuation in 1978 was 9.6% (about \$312 million) for crude oil and .9% (about \$32 million) for natural gas (ibid.).

## DESCRIPTION OF ALTERNATIVES INCLUDING THE PROPOSED ACTION

Although the Bureau of Land Management (BLM) exerts control over placement and rehabilitation of seismic lines and well locations, the discretionary action controlled solely by BLM is oil and gas leasing. Therefore, the primary alternative actions available to BLM for management of oil and gas activity relate to leasing.

Issuance of oil and gas leases means that the following corollary activities also occur: (1) the processing of notices of intent for geophysical exploration, (2) the administration of applications to drill oil and gas wells and notices to abandon them, and (3) the issuance of rights-of-way in support of the oil and gas program.

Present Bureau policy toward oil and gas leasing is based on both law and Bureau instructions. Subpart 3101.1 of 43 CFR states that all lands subject to disposition under the act (the Mineral Leasing Act of 1920) which are known or believed to contain oil or gas may be leased by the Secretary of the Interior, except for lands within national parks, Indian reservations, incorporated cities, and several other categories. Leasing, therefore, is a discretionary action. However, Bureau policy, as described in the BLM Manual 3000, is "to encourage the orderly development of the mineral resources under its jurisdiction," where such development is consistent with multiple-use management and environmental considerations. Furthermore, the Wyoming State Office Supplement to BLM Manual 3109 states that objection to leasing all or part of lands within a lease application "is valid only when impacts of oil and gas exploration or development cannot be satisfactorily mitigated, and the surface or environmental values are judged to be greater than the potential oil and gas resource."

The proposed action and alternatives described below represent several levels of environmental protection on a scale ranging from no leasing restrictions to the opposite extreme: protection criteria so stringent that no leasing could occur. Regardless of the number of environmental protection criteria applied to leasing, the actual leasing process, the permitting of corollary activities, and the development of oil and gas resources remain the same. These actions are, therefore, a part of the proposed action and each alternative. However, because these actions are many and complex, their description has been placed in a separate section of this chapter (see Detailed Account of Oil and Gas Actions).

### Proposed Action

BLM has established, through its land use planning system, certain criteria for environmental protection in the Buffalo Resource Area. The criteria and the rationale for their use are described in the Management Framework Plan (MFP) for the resource area. BLM's proposed action is to continue issuing leases, subject to the limitations imposed by the MFP, as well as by law. Under the proposed action, special management closures to or restrictions on leasing apply to approximately 2% of the federal mineral estate in the



resource area. The remaining 98% is open to oil and gas leasing with standard stipulations.

#### Law

Legal restrictions on leasing relevant to the resource area are (1) no leasing within incorporated city limits, and (2) special conditions for leasing in wilderness inventory units.

There are seven incorporated cities or towns in the resource area: Buffalo, Clearmont, Dayton, Gillette, Kaycee, Ranchester, and Sheridan.

There are three wilderness inventory units in the Buffalo Resource Area identified for further wilderness review: Gardner Mountain, North Fork, and Fortification Creek. BLM can issue leases in these areas, but must evaluate lease development proposals in accordance with the interim management policy for lands under wilderness review. In order to preserve existing wilderness characteristics in wilderness inventory units, no surface disturbance or other activities which would impair these characteristics will be permitted.

#### Management Framework Plan

Current MFP decisions pertaining to oil and gas leasing in the Buffalo Resource Area are listed below; they are summarized on the oil and gas stipulation overlay (see Map B, Appendix).

General Oil and Gas Leasing Restrictions. The entire resource area will remain open to oil and gas leasing and exploration subject to the following lease restrictions, unless waived by the District Manager.

--No surface disturbance will be permitted on slopes in excess of 25% until BLM personnel have inspected and specified stipulations for protection of the watershed. Examples of stipulations which may be attached to leases on the basis of field examinations include (1) requirements for engineering designs for access roads and drill pad locations, (2) restrictions on surface-disturbing activity during wet or muddy periods, except for well maintenance; and (3) no surface occupancy in places where slopes are 40% or more.

--No occupancy or other surface disturbance will be permitted within 200 feet of state and federal highways and county roads.

--No occupancy or other surface disturbance will be permitted within 500 feet of perennial (flowing year-round) streams, water wells, or reservoirs.

--No occupancy or other surface disturbance will be permitted within a 1.5-mile radius of sage grouse strutting grounds from March 1 through June 1 to protect nesting areas. No occupancy or other surface disturbance will be allowed within 250 yards of identified sage grouse strutting grounds at any time. This limitation does not apply to maintenance and operation of producing wells.

--No occupancy or other surface disturbance will be permitted within a .5-mile radius of sharp-tailed grouse dancing grounds from April 1 to June 1. No occupancy or other surface disturbance will be



allowed within 250 yards of identified sharp-tailed grouse dancing grounds at any time. This limitation does not apply to maintenance and operation of producing oil wells.

Environmental Protection Stipulations. The following stipulations are attached as applicable to leases within the Buffalo Resource Area to mitigate environmental impacts of oil and gas development.

--No occupancy or other surface disturbance will be permitted within .5 mile of active raptor nest sites from March 1 to June 30. (An active nest is one that has been used at least once during the previous three years.)

--No surface disturbance will be permitted in critical elk winter ranges (designated by the Wyoming Game and Fish Department) from November 30 to April 30 and in elk calving areas from May 1 to June 30.

--The lessee/operator will replant all forested areas on federal surface disturbed by oil and gas activity with 6- to 12-inch containerized seedlings of existing native species in a ratio of 1.5 seedlings to each tree removed. Tree planting will be in addition to grass and forb reseeding.

--Upon completion of rehabilitation work at a dry hole or abandoned well on federal surface, the lessee/operator will fence the entire location for two growing seasons to prevent livestock grazing. Exclusion of livestock from the site for two growing seasons by any other means is an acceptable alternative to fencing.

--All proposed actions that will disturb soil or vegetation or place a structure in the landscape will be evaluated for visual resource impacts in accordance with BLM Manual 6320. All phases of oil and gas development in visual resource management Class II areas must meet management standards for that class; i.e., that man-made changes should not be evident in the landscape. Specific plans for construction of roads and locations will be examined and suggestions offered by the Buffalo Resource Area Recreation Planner.

#### Restrictions and Closures in Special Management Areas.

Middle Fork and Red Wall.

--Request permission from the Secretary of the Interior to close the existing "withdrawal area" in Middle Fork Canyon to mineral leasing. While the decision is pending, or in the event of an unfavorable decision, administratively reject lease applications for this area.

--Request permission from the Secretary of the Interior to close the northern half of the Red Wall to mineral leasing and to mineral entry under the 1872 Mining Law. While the decision is pending, or in the event of an unfavorable decision, administratively reject lease applications for this area.



--Apply the following restrictions to existing mineral leases in the closed portions and to all mineral leases in the open portions of the Middle Fork and Red Wall management areas:

a. Obtain the assistance of the BLM Buffalo Resource Area Recreation Planner in production facility location to identify visual impacts. No production facilities will be located above ground in areas evaluated as Class A scenery.

b. Place roads on ridges where possible and do not allow sidecasting of material on ridgetop roads. If it is necessary to locate segments of roads on sidehills, the location should be screened by existing vegetation beneath the toe of the fill. Vegetation should screen the road cut from view at a horizontal sight distance of 200 feet.

c. Obtain the assistance of the BLM District Engineer in road location and crossings of flowing streams to assess the feasibility of construction. Roads are to be constructed to the standards in Wyoming State Office Manual Supplement 3109.

d. Avoid construction through juniper, mountain mahogany, or other timber stands, unless the vegetation is to be used to screen the disturbance.

e. Drill no wells on ridges. Move proposed ridgetop well sites to sidehill areas or other locations to avoid skylining facilities.

f. Allow no new overhead power lines. An overhead extension of an existing overhead line may be allowed by the District Manager.

g. All production facilities will be painted in earthtone colors, complementary to colors of the natural landscape at the site. (see Chapter 3, Mitigating Measures for Surface-Disturbing Activity, #67.)

h. All equipment will be muffled so that sound pressure levels at 100 feet from the source do not exceed 65 decibels. Subsurface mufflers may be required.

i. Waterbars are required whether the well is a dry hole or a producer. Waterbar locations will be designated on the ground. Waterbars will be constructed at the top of the backslope and at the top of the foreslope, with a ditch at the bottom of the backslope. They will be constructed on the contour, approximately 1.5 feet deep into undisturbed land, and will be compacted and constructed so they drain onto established vegetation. Bar at top of backslope should be 3 to 4 feet back from edge of cut.

j. Drilling will be allowed only between July 1 and November 30 to protect watershed and wildlife values.

Bud Love, Amsden, and Kerns Big Game Ranges.

--Lease these three areas, which total 4,600 acres, with no surface occupancy. (During public meetings on the Western Powder River MFP, Wyoming Game and Fish Department personnel indicated they are opposed to leasing of federal minerals under their game ranges. However, BLM allows leasing with no surface occupancy to prevent



drainage of federal oil and gas by wells drilled into private minerals.)

Federal surface within the Ed O. Taylor Game Range in southwest Johnson County has been withdrawn from mineral entry under the 1872 Mining Law. The southern portion of the game range is included in the Middle Fork Canyon area proposed for withdrawal from mineral leasing. Seasonal restrictions on oil and gas activity apply to the northern portion of the game range.

#### Fortification Creek.

--Oil and gas development will be allowed in the Fortification Creek area only where on-the-ground inspection indicates mineral development can take place without destroying critical watershed, wildlife, and natural values.

Stipulations based on field examinations and derived for the protection of these values in the Fortification Creek area include (1) no surface occupancy on slopes of 25% or more; (2) power lines will be buried; (3) no surface disturbance in elk calving grounds May 1 to June 30; (4) no surface disturbance in elk critical winter range from November 30 to April 30; (5) replacement of trees removed with containerized seedlings; (6) barricading rehabilitated access roads to prevent vehicular travel; and (7) muffling engines so that noise levels do not exceed 86 decibels at 50 feet.

#### Significant Cultural Sites.

--Lease the Bozeman Trail, Cantonment Reno, Crazy Woman Battlefield, Dull Knife Battlefield, the Kinney Crossing Site, and a .25-mile buffer zone surrounding each site with no surface occupancy. An additional .5-mile scenic corridor will be maintained around each area. Facilities within these corridors should be camouflaged to be compatible with the surrounding scenic values.

#### Dry Creek Petrified Tree Area.

--Twenty-five acres in the Dry Creek Petrified Tree area will be leased with no surface occupancy.

#### Environmental Education Areas.

--No surface occupancy will be permitted in the Little Powder River and the Spring Creek environmental education areas.

#### Pumpkin Buttes.

--Develop stringent stipulations for public lands on North and South Middle Pumpkin buttes to protect scenic quality and to prevent watershed damage: no surface occupancy will be permitted on the tops of these two buttes.

#### Other MFP Decisions.

#### Oil Field Plans.



--Where major new oil fields are anticipated, BLM will, in consultation with the private surface owner, the oil company, and Geological Survey, prepare oil field plans to minimize impacts on other land uses and environment.

Utility Corridor System. Because of increasing mineral activity in the Powder River Basin, a corridor study with recommendations for Campbell County was prepared in 1977. The MFP decision was to accept the recommendations of the study for the whole resource area.

Rights-of-way proposed for utility corridor systems include pipelines, electric power lines, major collector highways, and railroads. Corridor locations and operating criteria are as follows:

Power Lines: Any line with an "H" type structure or larger.

Pipelines: Any line 6 inches in diameter or larger, regardless of volume.

Highways: Major collector highways.

Railroads: All main railroad lines leading out of the resource area.

In effect, this recommendation would establish corridors around existing facilities. New corridors would only be considered when location within a compatible distance of existing facilities could be demonstrated to be impractical and unfeasible, and where the environmental impact could be mitigated. A compatible distance will be determined on a case-by-case basis considering minimum design standards for the system considered and major impacts to the human environment.

#### Alternative #1

One alternative to the proposed action is to increase above current levels the number or the intensity of criteria for environmental protection, and thereby to reduce the area available for leasing.

During preparation of this environmental assessment, the resource specialists developed several new environmental protection criteria, listed below. These criteria are based on the analysis of environmental impacts of oil and gas activity (see Chapter 2) and/or resource data made available since the MFP was last revised.

If alternative #1 is selected, and if these new criteria, plus those already part of the MFP, are used to determine which lands will be afforded special environmental protection, approximately 5.5% of the federal mineral estate of the resource area would be subject to special management closures or restrictions, and the remaining 94.5% would be open to leasing. (Selection of this alternative, or any part of it, would necessitate amendment of the MFP.)

Under alternative #1, the following restrictions would be applied:



## Protection of Wildlife and Wildlife Habitat

1. Allow no surface occupancy in the northern portion of the Ed O. Taylor Big Game Range, i.e., that portion not included in the proposed Middle Fork Canyon leasing withdrawal area. The purpose of this alternative is to make adequate and consistent the protection BLM affords to elk and their habitat on all big game ranges managed by the Wyoming Game and Fish Department in the resource area.

2. Allow no surface occupancy in elk critical winter ranges in the Fortification Creek area and the southern Big Horns outside the designated big game ranges (see Map G, Appendix). Any land farther than .5 mile from a place acceptable for occupancy would not be leased.

3. The U.S. Fish and Wildlife Service has not issued guidelines for the protection and management of eagle roosts in Wyoming. In lieu of such guidance, lease oil and gas beneath eagle roosts with the following stipulation:

"No surface occupancy will be permitted at any time within .5 mile of the communal eagle winter roost in (legal description). From November 1 to March 30, no surface disturbance will be allowed for an additional .5 mile around the roost."

## Protection of Cultural Resources

4. Allow no surface occupancy in the Outlaw Cave archeological district (see Map I, Appendix). (An archeological district is a geographical area possessing a significant concentration of cultural resources united by past events -- see Chapter 2, cultural resources section.) Land farther than .5 mile from a place acceptable for occupancy would not be leased. (Part of the Outlaw Cave archeological district lies within the Middle Fork and Red Wall withdrawal areas.)

5. Attach the following stipulation to leases where sites listed or considered eligible for listing on the National Register are known to exist. Approximate locations of current National Register or National Register eligible sites are shown on Map I, Appendix. (Specific site locations are not public information, and are not included in this document.) Sites listed on or determined eligible to the National Register in the future would receive the same protection.

"No surface occupancy will be permitted on National Register eligible site (name or number of site), and a buffer zone, determined through field examination, will be specified, if needed. The buffer zone will take into consideration factors such as visual intrusion, integrity of location, design, setting, materials, workmanship, feeling, or association of the property that contributes to its significance in accordance with National Register criteria."

In the event that national energy requirements necessitate disturbance of, or impact to, any currently listed or eligible site, or any identified in the future, detailed site-specific stipulations, listed in Chapter 3, would be used, and consultation with the Wyoming



State Historic Preservation Officer, and possibly the Advisory Council on Historic Preservation would be required.

#### Protection of Recreation Areas

6. Allow no surface occupancy in the recreation and public purpose areas for the cities of Gillette and Sheridan (see Map K, Appendix).

#### Prevention of Mineral Resources Conflicts

7. On lands which are part of federal coal leases for which mining and reclamation plans have been approved (see Map L, Appendix), defer oil and gas leasing until coal mining is completed.

#### Alternative #2 (No Action)

A second alternative to the proposed action is to set such stringent environmental protection restrictions that no leasing would be allowed in the resource area. This means that no new leases would be issued by BLM, current leases would not be renewed as they expire, and leases under production would not be renewed when production ceases.

Closure of the entire resource area to further oil and gas leasing is not a viable alternative under present legal and Bureau policy, described at the beginning of this section.

Closure of the entire resource area to leasing is also an unreasonable alternative in view of national energy needs and policies.

Furthermore, BLM believes that, in most cases, environmental protection can be assured during oil and gas development activity by the judicious use of construction and reclamation stipulations.

#### Alternative Considered and Rejected

##### Alternative #3

An alternative to reduce the number of environmental protection measures currently existing (and hence to open more areas to leasing than under the proposed action) was considered and rejected. No new information is available to indicate that the degree of protection BLM offers under its current land use plan decisions is too great. On the contrary, resource value considerations support increasing the degree of environmental protection.

##### Alternative #4

BLM presently attaches environmental protection stipulations to the oil and gas leases it issues. Lease stipulations range from restriction on surface occupancy or season of use to requirements for camouflaging paint on structures. The stipulations are based on

resource data kept at the Buffalo Resource Area office and field examinations. During some seasons of the year, field examinations are impossible and action on proposed leases must be delayed. BLM could prevent such delays by issuing leases without any restrictions, waiting to prepare stipulations until the lessees submit applications for specific surface-disturbing activities. This alternative was rejected for two reasons: (1) management decisions would be inconsistent, and (2) lessees might be saddled with unexpectedly tough construction or drilling restrictions if their leases fell in critical environmental areas.



## DETAILED ACCOUNT OF OIL AND GAS ACTIONS

Note: This section of the environmental assessment is a detailed description of the leasing process, the permitting procedures for oil and gas development, and on-the-ground activities. It is included because it is a part of the proposed action and, as such, serves as the basis for the impact analysis in Chapter 2. Many readers who are familiar with the actions described may wish to skip this section of the document.

Activities or actions connected with oil and gas operations can be divided into six distinct phases: preliminary exploration, leasing, drilling, oil field development and production, field abandonment, and issuance of rights-of-way.

### Preliminary Exploration for Oil and Gas

#### Geology

Crude oil and natural gas occur as fluids associated with water in porous sedimentary rocks such as sandstone. Since petroleum and natural gas are less dense than water, they rise until trapped by a barrier, usually an impermeable rock layer. Oil and gas fields in the Buffalo Resource Area are of two types: anticlinal (convex upward) fold and stratigraphic trap (Figure 1-3). The most important petroleum-bearing formations in the resource area are sandstones of Cretaceous age, particularly the Muddy Sandstone, and the Minnelusa Formation (Figure 1-4).

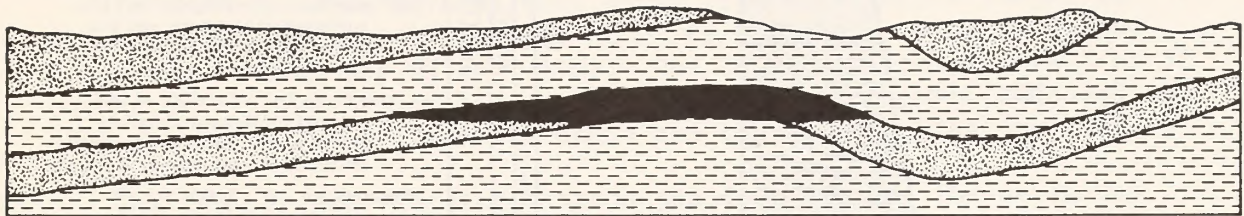
#### Methods

The likelihood of the presence of oil and gas is often determined by geological prospecting, or the examination of surface geology. Such prospecting can be done on the ground, where off-road vehicle travel may be necessary, or by aerial survey. Photographs from orbiting satellites have also been used to identify surface structure.

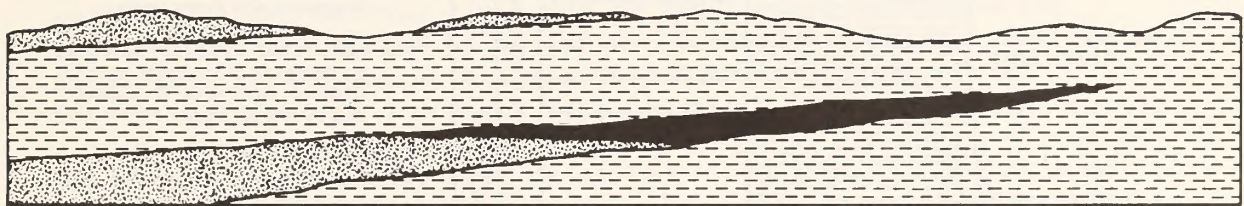
Subsurface geology is not always accurately indicated by surface outcroppings. To prove surface indicators and to map the subsurface structures, geophysical exploration is used. There are three types of geophysical exploration: gravitational field, magnetic field, and seismic characteristics.

Gravitational prospecting detects variations in gravitational attraction caused by the differences in the density of various types of rock. Magnetic prospecting often replaces or is used to supplement gravitational work. Magnetic methods reveal upheaved structures (likely to yield oil and gas) because such structures show a strong magnetic response. Gravitational and magnetic prospecting equipment is usually transported by pickup or helicopter. The only surface disturbance is that caused by the vehicle.

Seismic prospecting is the most popular of the geophysical methods, since it gives the most reliable and reproducible results. Shock waves are initiated using a thumper or vibrator on the surface, or explosives in the bedrock. The waves travel through or are



ANTICLINAL FOLD TRAP



STRATIGRAPHIC TRAP

SOURCE: BLACKSTONE, 1971

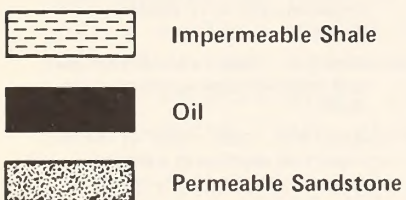


Figure 1 - 3  
Structural Traps For Crude Oil and Natural Gas



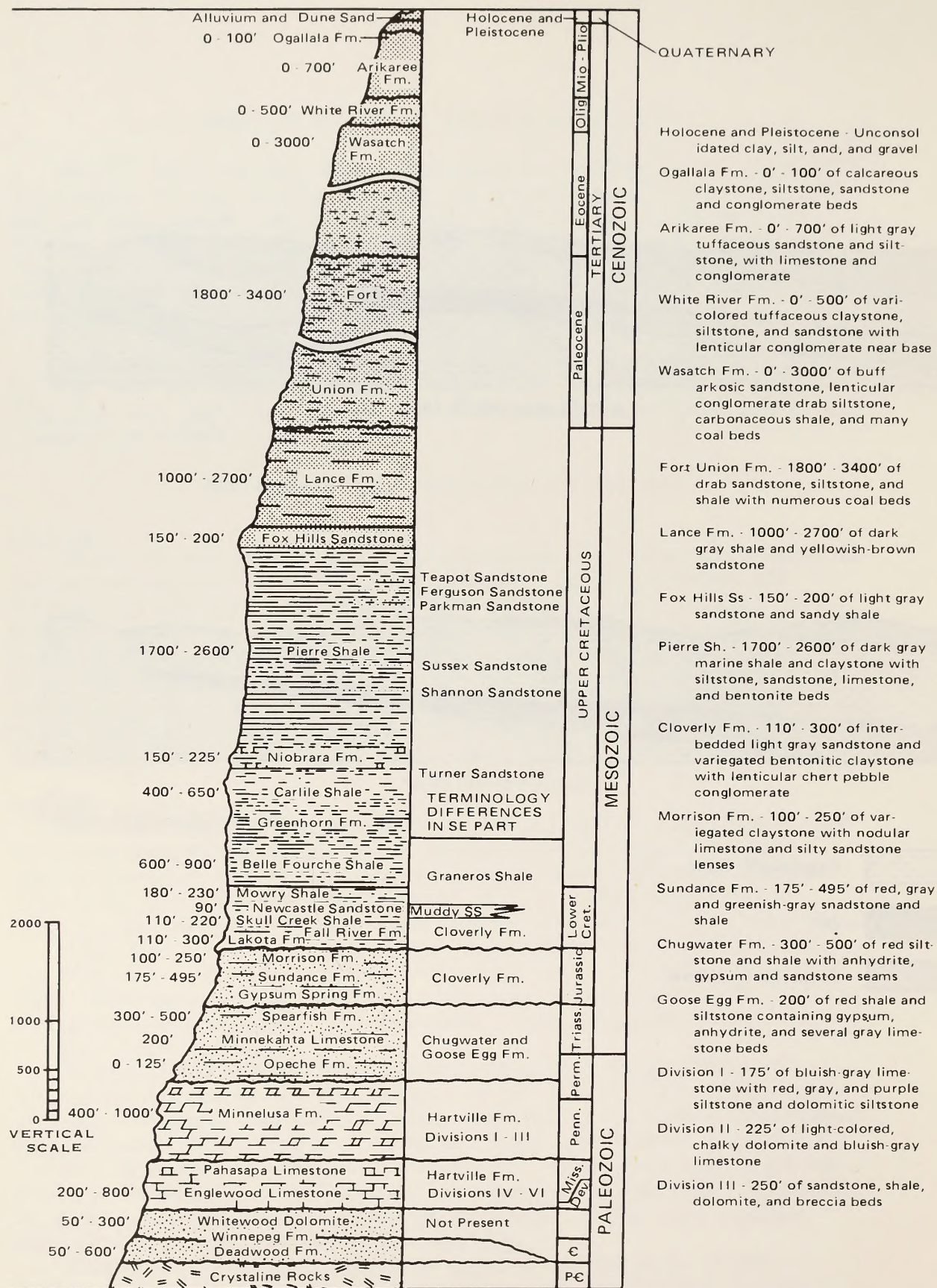


Figure 1 - 4  
Columnar Section of Rock Sequence in the Eastern Powder River Basin  
and Description of Exposed Formations



reflected from various rock layers, and are received by shock sensors. The sensors are connected to a truck where the shock waves are recorded. The time required for shock waves to travel through the rock formations yields useful information.

In the explosive method, shot holes, approximately 6 inches in diameter, are drilled to a depth of 50 to 200 feet. Four to twelve holes are drilled per mile of line. The holes are loaded with 5 to 50 pounds of explosives and detonated. The same hole may be reloaded and shot several times to find the depth and charge returning the best signal.

The thumper and vibrator methods pound or vibrate the earth to create a shock wave. Vibrator methods are widely used and are replacing the drill and shot method. Usually four large trucks are used, each equipped with vibrator pads (about 4-feet square). The pads are lowered to the ground and vibrators on all trucks are triggered electronically from the recorder truck. Information is recorded and then the trucks move forward a short distance and the process is repeated. Less than 50 square feet of surface area are required to operate the equipment at each test site.

In remote areas where there is little known subsurface data, a series of short seismic lines may be required to determine the regional dip and strike of subsurface formations. After this, seismic lines will be aligned with these formations to make seismic interpretation more accurate. The seismic sensors and energy source are located along lines on a 1- to 2-mile grid. Although alignment may be fairly critical, spacing of the lines can often be changed .25 mile on a 1-mile grid before the results will affect the investigation program.

A typical drilling seismic operation may utilize ten to fifteen men operating five to seven trucks. Under normal conditions, 3 to 5 miles of line can be surveyed each day using the explosive method. The vehicles used for a drilling program included several heavy truck-mounted drill rigs, water trucks, a computer recording truck, and several light pickups for the surveyors, the shot-hole crew, the geophone crew, the permit man, and the party chief.

Public roads and existing private roads and trails are used. Off-road cross-country travel is also necessary. Motor graders and/or dozers may be required to provide access to remote areas. Several trips a day are made along a seismograph line; this usually establishes a well defined two-tracked trail. Drilling water, when needed, is usually obtained from private landowners or local city officials.

#### Responsibilities

Notices of Intent for geophysical exploration are required for all lines (in their entirety), if any portions of the lines cross federally owned surface. Notices of Intent are to be filed and processed according to the requirements of 43 CFR 3045 and Wyoming State Office Supplement 3045. The steps required of the operators and the Bureau of Land Management (BLM) are described in Oil and Gas:



Surface Operating Standards for Oil and Gas Exploration and Development, second edition, prepared by the BLM, Geological Survey (GS), and Forest Service (August 1978). BLM checks compliance with stipulations for portions of the line on federal surface.

Alternatives. The action cannot be denied, except in wilderness inventory units. The only alternative is to persuade the operators to alter proposed seismic routes or lines, if there is a conflict with critical resources. (A change in federal regulations has been proposed such that BLM permits would be required for geophysical exploration on federal surface.)

#### Leasing

The actual leasing of an area is an administrative action and, in itself, causes no impact. However, the issuance of a lease authorizes the lessee to actively explore and develop the lease, guided by the stipulations attached to the lease. The importance of stipulations that are attached to the lease should be stressed. They are attached to the lease when the lessee accepts it and serve to point out possible areas of critical environmental concern.

Oil and gas leases fall into two categories--competitive and noncompetitive. (This could change, if legislation now before Congress is passed. The proposed legislation would allow only competitive bidding for lands within a producing geologic province which are favorable for the discovery of oil or gas.)

Competitive leases are for lands inside known geologic structures (KGS) which are determined by GS. A KGS is technically the geologic trap in which a productive accumulation of oil or gas has been discovered by drilling, the limits of which include all acreage that is presumptively productive. If leasing is recommended by GS, land nominated by the public is combined with GS nominations, and a competitive lease sale is scheduled. BLM conducts the sale. Sealed bids are accepted for each tract. For each bid deemed adequate and accepted, a lease is issued, and the lessee is required to pay a cash bonus. Competitive leases are issued for a term of 5 years or as long as oil is produced. By federal regulation, the acreage may not exceed 640 acres.

Noncompetitive leases are for lands outside a KGS. Noncompetitive leases are of two types, those that appear on the simultaneous list and those that are open land offers. Proposed regulations were published September 28, 1979, which would change a number of the procedures related to the simultaneous list (44 FR No. 190, 56176-56181). Procedures described here are according to current regulations.

The simultaneous list is composed of previously leased parcels in non-KGS areas; these are listed monthly as they become available following termination of old leases. After a list is approved and advertised, all applications for the parcels are accepted and a lottery-type drawing is held. If there are no applications for a tract, it becomes an open land offer and is available to the first



applicant subsequent to the drawing. Noncompetitive leases are issued for 10 years or as long as oil is produced. By federal regulation, the acreage may not exceed 2,560 acres.

Rent payment in advance, plus royalties based on production, are required on all leases. Rent on noncompetitive leases is \$1.00 an acre per year. Upon production of oil and gas, the royalty is 12%. Rent and royalties on competitive leases are prescribed in the lease terms. Prior to issuance of either competitive or noncompetitive leases, the lessee must post a surety bond to ensure compliance with lease stipulations.

#### Action and Alternatives

All oil and gas leases, whether competitive or noncompetitive, are processed through the BLM Wyoming State Office (WSO). The Buffalo Resource Area Manager is the Casper District Manager's representative for prelease investigations and recommendations in Campbell, Johnson, and Sheridan counties.

The lease offers are sent to the Buffalo Resource Area for comparison with planning decisions and assignment of resource protection stipulations or no-leasing recommendations; they are then returned to WSO for issuance or drawing.

Response time for the Buffalo Resource Area to reply to WSO concerning a competitive lease is 1 month, unless more time is needed for review. The response time for the simultaneous list is by the second Monday of the month for which the list is compiled.

When a proposed oil and gas lease is received at the Buffalo Resource Area there are two alternatives available: recommend leasing with the attachment of special stipulations, or recommend no leasing.

Stipulations. Stipulations attached to leases are determined on the basis of the BLM Manual, WSO instructions, Management Framework Plan (MFP) decisions, and, in some cases, field examinations. Current MFP decisions are described in Description of Proposed Action, above.

Ten standard stipulations and a so-called "wilderness stipulation" have been agreed to by BLM and GS for attachment to oil and gas leases (see Appendix). Use of those standard stipulations pertaining to no surface occupancy requires GS concurrence, as does use of any nonstandard stipulations.

When the potential impacts from oil and gas exploration or development cannot be mitigated and the surface values are judged to be greater than the potential oil and gas resource, no surface occupancy is allowed. The no-surface-occupancy stipulation is to be used only on leases or portions of leases that are .50 mile or less in width from the nearest place acceptable for occupancy (Figure 1-5).

It is assumed directional drilling can be utilized to tap an oil or gas pool within the no-surface-occupancy zone (Figure 1-6). However, the feasibility of directional drilling is dependent on geological structure and rock composition, and must be checked with GS. (The difference between directional drilling and conventional drilling consists of the directional drilling assembly that is attached to the drill pipe. Directional drilling adds expense to



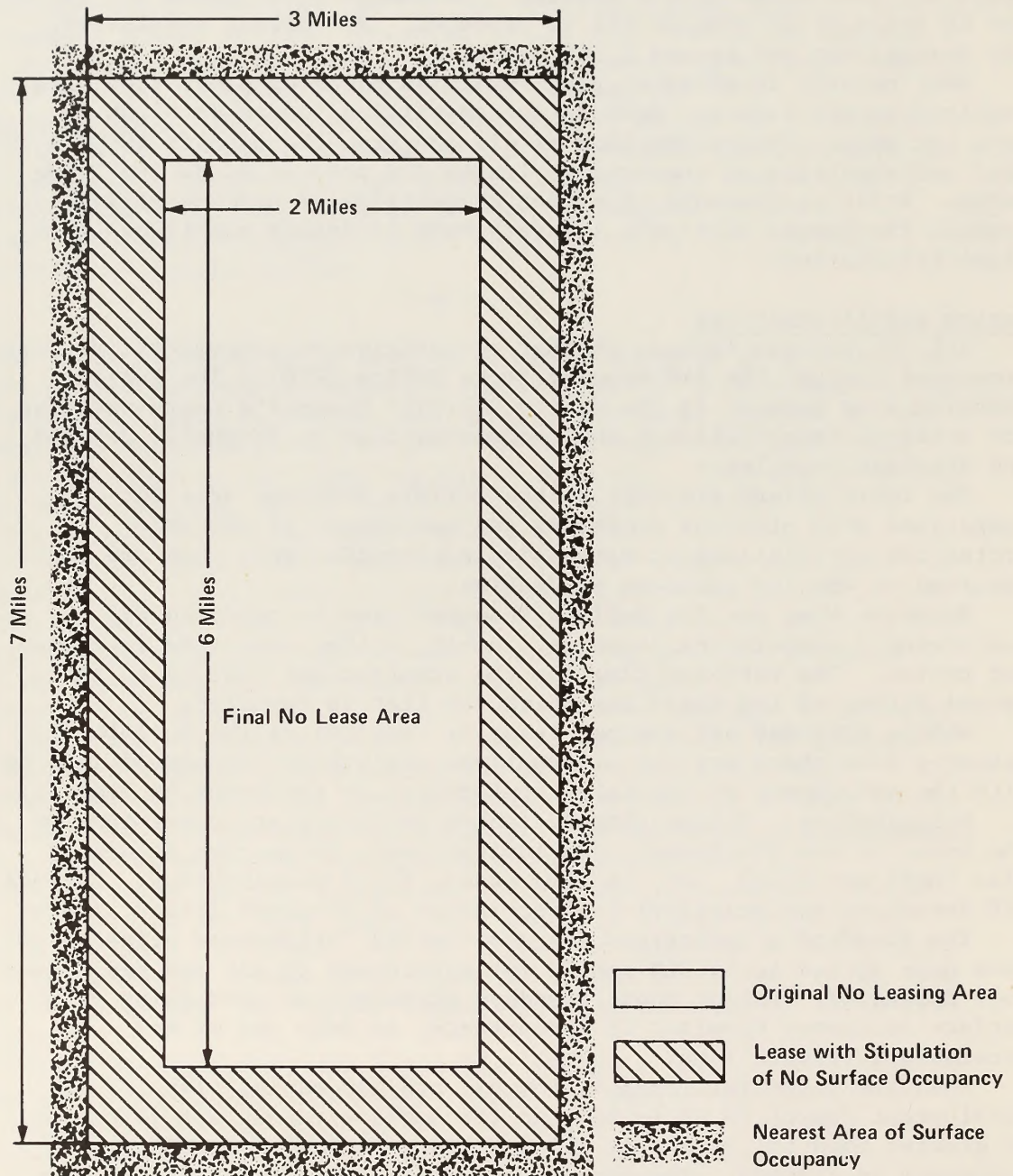
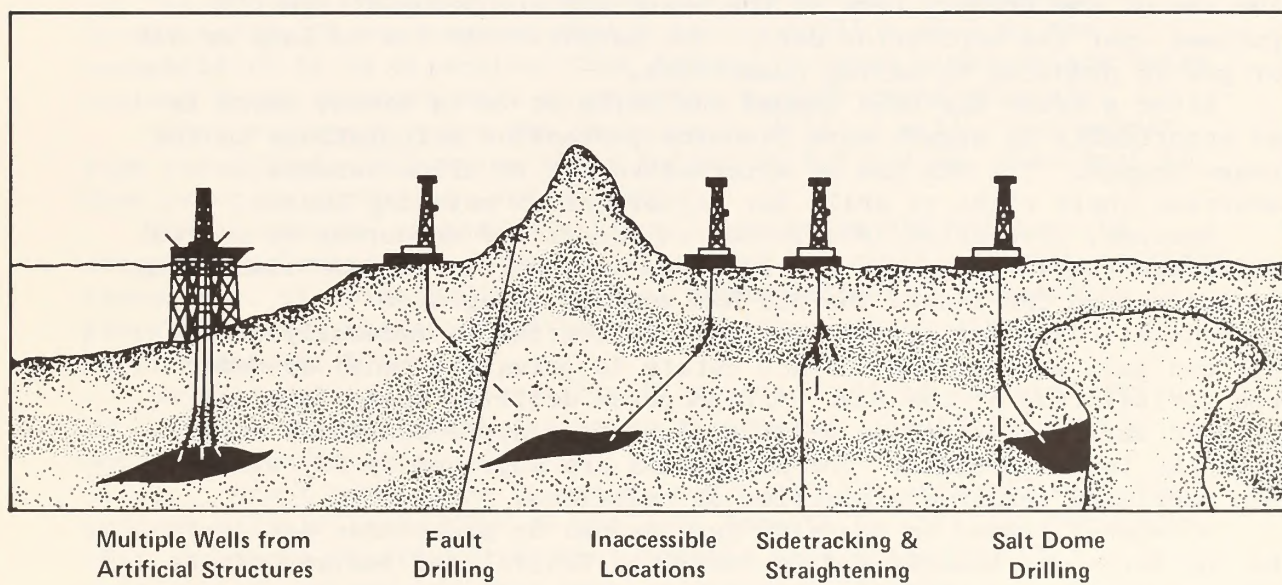


Figure 1 - 5  
Example Of No Leasing Area With Adjacent Lease  
With No Surface Occupancy



SOURCE: PETROLEUM EXTENSION SERVICE, 1970

Figure 1 - 6  
Applications of Directional Drilling



drilling costs by requiring special equipment and personnel, as well as a greater length of drilling time, such as 60 days on a well that would normally take 30 days.)

No Leasing. The area manager can recommend no leasing for all or portions of oil and gas leases that are farther than .5 mile from any place of acceptable occupancy, because the oil and gas reserves cannot be tapped by directional drilling.

#### Administration of Existing Leases

After an oil or gas lease has been issued, the lessee has up to 5 or 10 years, depending on the type of lease, to start actual drilling operations, or the lease will be terminated. An extension of 2 years may be granted if actual drilling operations are commenced prior to the end of the primary term of the lease and are being diligently pursued over the expiration date. The extension is for as long as oil or gas is produced in paying quantities.

After a lease has been issued and while it is in force, there is no opportunity to attach more resource protection stipulations to the lease proper. The BLM has no alternative but to allow lessees to exercise their right to drill for oil or gas on existing leases.

However, protection is afforded to identified resources at several different times throughout the lifespan of specific surface-disturbing activities on the lease. The BLM has surface management responsibilities for all oil and gas activities on federally owned oil and gas, whether the surface estate is privately owned or under the jurisdiction of the BLM. All proposed drilling operations and related surface-disturbing activities must be approved before entry upon the lands involved. The activities are approved by GS, with BLM providing resource protection stipulations.

A federal lessee or operator is governed by procedures set forth by the Notice to Lessees and Operators of Federal and Indian Onshore Oil and Gas Leases (NTL-6). NTL-6 lists the following as pertinent points to be followed by the lessee or operator: preliminary environmental review (PER); application for permit to drill (APD), which includes a multi-point surface use and operations plan; approval of subsequent operations; agreement for rehabilitation of privately owned surface; well abandonment; and water well conversion (see Surface Operating Standards for Oil and Gas Exploration and Development). Lessees or operators must also apply for rights-of-way if they construct transportation or utility lines across federal surface. These points are addressed in more detail below.



## Drilling Operations

### Preliminary Environmental Review (PER)

The federal lessee or operating company selects the location of a proposed drill site. The selection of the site is based on spacing requirements, the probability of finding hydrocarbons as indicated by geologists and geophysicists, the topography, and the availability of funds for a specific well. (Spacing requirements are established by the Wyoming State Oil and Gas Commission. Each well is to be drilled within a given distance from the center of a subdivision (such as a quarter/quarter of a section or a quarter section, depending on the spacing assigned to the particular area). A proposed location may be moved within the tolerance or (with a spacing exception obtained from the Oil and Gas Commission) outside the designated tolerance.) Occasionally, GS may request that a lessee drill a well on the leasehold if it is determined that federally owned minerals are being drained by an adjacent well on private or state-owned minerals.

After a company makes the decision to drill a well, they submit maps and letters indicating their intent to BLM and GS. This must be done prior to surveying and staking.

BLM checks the proposed drilling location on the oil and gas stipulations overlay (see Map B, Appendix) for conflicts with critical resources. If there are no critical areas indicated, permission is given to survey the proposed location and to proceed with the requirements of NTL-6.

Several options are available if proposed oil or gas activity is in conflict with critical resources or areas as identified by the Buffalo Resource Area.

1. Grant permission to survey and stake the proposed well and conduct a field inspection to evaluate impacts to critical resources that are to be considered by the operator when preparing the multi-point surface use plan that accompanies the APD.

2. Consult with the U.S. Fish and Wildlife Service if it is determined that drilling activities could jeopardize the existence or modify essential habitat of any federally listed threatened or endangered species.

3. Prepare a point-specific EA or EIS for any proposed location that is within a wilderness inventory unit (North Fork, Gardner Mountain, Fortification Creek) or a wilderness study area.

Conducting an on-the-ground inspection in conjunction with a PER (or in preparation of an EA or EIS for a wilderness inventory unit) requires travel over public roads, private roads, and trails, as well as off-road cross-county travel. This travel takes place even though weather and travel conditions may be inclement.

A PER is required for both oil field development wells and wildcat exploration wells. Due to the potential for future conflict with resources which may be unknown when PER clearance is given, the PER is only cleared for 6 months. If the clearance is not exercised and an APD is not filed within the 6-month time period, another PER must be filed before the company drills at the location.



### Surveying

Surveying a proposed well site requires travel over public roads, private roads and trails, and off-road cross-county travel. Since drilling oil and gas wells in the Buffalo Resource Area is a year-round activity, surveying and, therefore, travel is done under all weather conditions (ranging from sunny to extended periods of snow or rain).

A proposed well location must be surveyed from an established corner. Because there are large areas within the Buffalo Resource Area which have not been surveyed by cadastral survey, operators must, at times, survey for distances of 4 to 12 miles to tie a proposed well location into an established corner.

### Application for Permit to Drill (APD)

After the PER process has been accomplished and before any surface activity is conducted in conjunction with the drilling of an oil or gas well, the operator must submit to GS an APD and an agreement with the surface owner, if the land surface is privately owned. (The latter lists the surface owner's rehabilitation requirements. These requirements, if deemed not unreasonable by the GS and BLM, are considered to be stipulations to the plan. If a surface owner requests measures which may be harmful to the environment, every possible effort is made to negotiate alternate measures.)

The APD is forwarded to the Casper District, Division of Operations. A field inspection with representatives of GS, BLM, lessee or operator, and any other interested party (such as the dirt contractor or surface owner) is held. The presite field inspection entails travel on public roads, private roads, and trails, and off-roadcross-country travel with pickups and, at times, snow machines. Helicopters are occasionally used.

The purpose of the presite field inspection is to evaluate the operator's plan, to assess the situation for possible impacts, and to formulate resource protection stipulations (see Chapter 3). To lessen environmental impacts, a site may be moved, reoriented, or redimensioned, within certain limits, at the presite inspection. The proposed access road may also be rerouted.

Stipulations are sent to GS as conditions of approval for a well site. At this time, if the proposed well is on federally owned surface under the jurisdiction of the BLM, BLM states whether or not it wishes to acquire the oil or gas well for a water well at the time of abandonment.

Prior to approval of an APD, an archeological clearance must be obtained by the operator. This entails at least one trip to the area of the well location and may require cross-county travel in addition to use of public roads and private roads and trails.

GS is responsible for preparing an environmental impact assessment prior to the approval of an APD. The final approval of an APD is given by GS, and the operator may commence construction activities. Approval of an APD is for a year, with no extensions. The delay may



mean that stipulations formulated to apply during one specific season of the year are used during another season, a time when they may not be applicable.

After an application for permit to drill (APD) is approved, GS assigns an area of operation (AO) to each well. For exploratory wells, the AO assigned to an oil well is 160 acres, and to a gas well is 640 acres. The AO for wells within a producing field is determined by the productive capacity of the reservoir and, if necessary, the spacing unit for the field.

All activities within an AO carried out in conjunction with an oil or gas well are approved and enforced by GS with surface protection input by the Casper District, Division of Operations. All activities and surface use requirements outside the limits of established AOs and not crossing federally owned surface are the responsibility of the Casper District, Division of Operations. Rights-of-way and temporary use permits for access roads and pipelines that cross federally owned surface outside the AO are the responsibility of the Buffalo Resource Area. The Buffalo Resource Area notifies the GS of all applications which involve other surface uses of the lands within an AO, for GS recommendations prior to approval of the application.

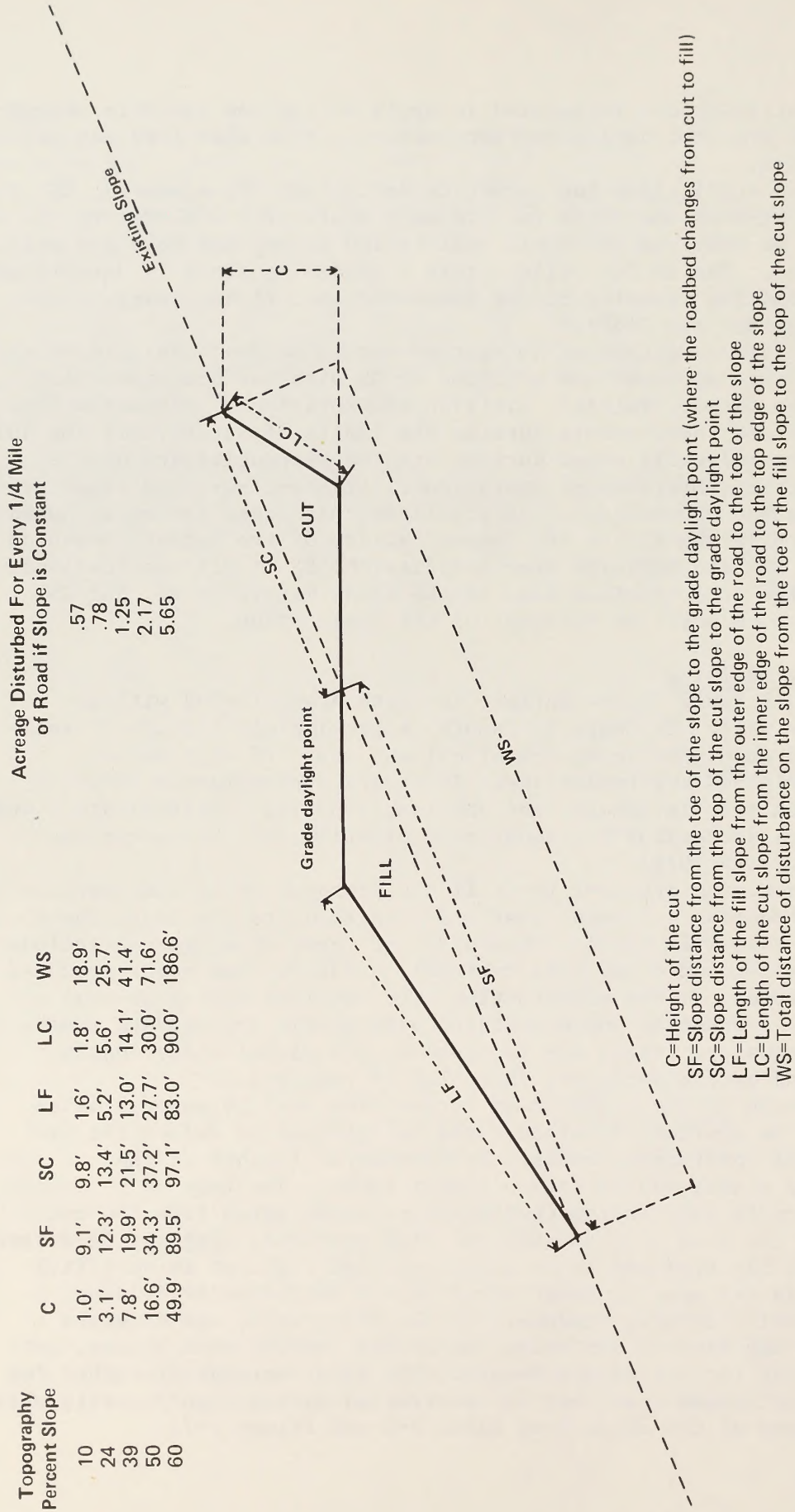
#### Exploratory Drilling

Every oil field in the Buffalo Resource Area started with an exploratory well. In Campbell County, approximately 150 to 170 wells are drilled each year in search of oil and gas. Of this amount, approximately 36% are productive. There are approximately 45 wells drilled each year in Johnson and Sheridan counties. Approximately 46% of these are successful (personal communication, GS, Newcastle and Casper, February 1979).

Upon receiving approval to drill the proposed well, the operator moves construction equipment over existing roads to the point where the access road will begin. Generally the types of equipment include dozers (track-mounted and rubber-tired), scrapers, and motor-graders. Moving equipment to the construction site requires moving several loads (some overweight and overwidth) over public and private roads. Existing roads and trails are improved in places and occasionally culverts and cattleguards are installed if required.

The length of the access road varies from feet to several miles. Generally the shortest feasible route is selected to reduce the haul distance and construction costs. Environmental factors or the landowner's wishes may dictate a longer route. The type of construction is sidecasting (using the material taken from the cut portion of the road to construct the fill portion); slightly less than one-half of the road bed is on a cut area and the rest is on a fill area. Roads are usually constructed with a 16-foot-wide driving surface. Soil texture, steepness of the topography, and moisture conditions may dictate surfacing the access road in some places, but generally not for the entire length. The total acreage disturbed for each mile of access road that is constructed varies significantly with the steepness of the slope (see Table 2-2 and Figure 1-7).





Specifications: Side hill cut  
 16 - foot driving surface  
 Fill slope - 1.5 to 1  
 Cut slope - 1.5 to 1

Figure 1 - 7  
 Disturbance Caused By Access Road Construction

Well locations are constructed by one of three different general types of construction, but in every case, all soil material suitable for plant growth is first removed from areas to be disturbed and stockpiled in a designated area. Sites on flat terrain usually require little more than removing the topsoil material and vegetation. Drilling sites on ridge tops are constructed by removing material from the ridge and pushing it down the hillsides in both directions until sufficient level area is created. On locations constructed on hillsides, material is removed from the hillside and pushed downhill to form the outer edge of the location until sufficient operating area is obtained.

The amount of level surface required for safely assembling and operating a drilling rig varies with the type of rig, but averages 300 feet by 350 feet (see Figures 1-8 and 1-9). At least 25 feet is required, to be on an area of cut and not fill, between the drill point and the outer edge of the drilling platform. This ensures that the drilling derrick does not lean or topple due to settling of uncompacted soil.

In addition to the drilling platform, a reserve pit is constructed, usually square or oblong, but sometimes in another shape to accommodate topography. Generally, the reserve pit is 8 to 12 feet deep, but may be deeper to compensate for smaller length and width.

Depending on the relation of the location to natural drainages, it may be necessary to construct water bars or diversions.

The area disturbed for construction and the potential for successful revegetation depends largely on the steepness of the slope (see Figures 1-10 through 1-14 and Table 2-2).

Usually drilling activities begin within a week or two after the location and access road have been constructed. The drilling rig and associated equipment are moved to the location and erected. Moving a drilling rig requires moving 10 to 25 truck loads (some over legal weight and height) of equipment over public highways and private roads. The derrick when erected is approximately 160 feet high.

Water for drilling is hauled to the reserve pit or transported by surface pipeline. Water sources are rivers, wells, or reservoirs. Occasionally, water supply wells are drilled on or close to the oil or gas well drilling location. The operator must obtain a permit from the Wyoming State Engineer for the use of surface or subsurface water for drilling. When drilling commences and as long as it progresses, water is continually transported to the reserve pit. Approximately 40,000 barrels or 1,680,000 gallons of water are required to drill an oil or gas well to the depth of 9,000 feet. More water is required if the underground structure is fractured enough to permit water to escape into it.

Starting to drill is called "spudding in" the well. The initial drilling through shallow formations proceeds rapidly, and generally a string of surface casing is set before harder, deeper formations are encountered. The surface casing is a long length of steel pipe which is cemented into the well to protect against water or rock getting into the well. It is large enough to allow subsequent lengths of



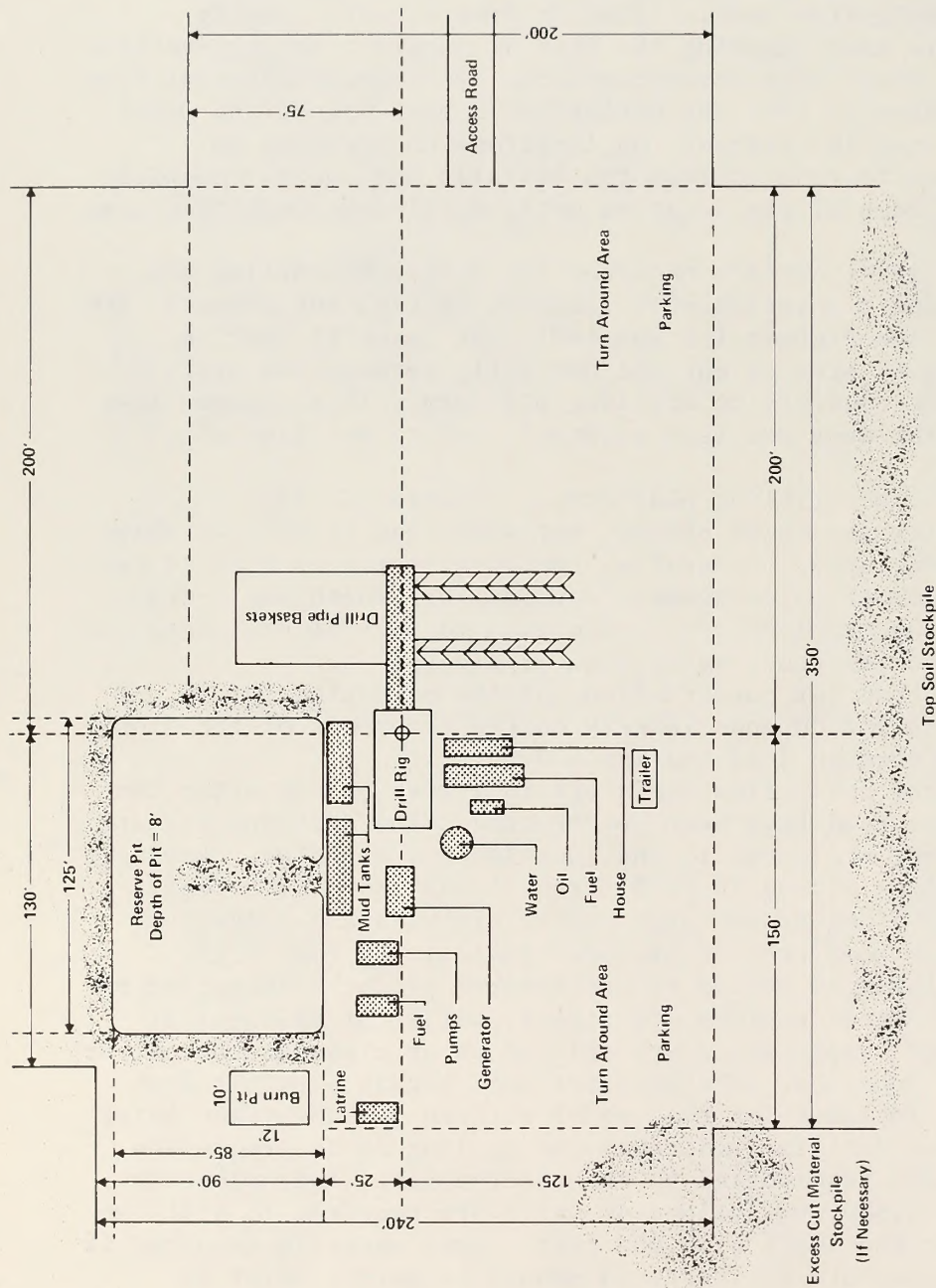


Figure 1 - 8  
Location Layout For A Well 6,000 to 9,000 Feet Deep

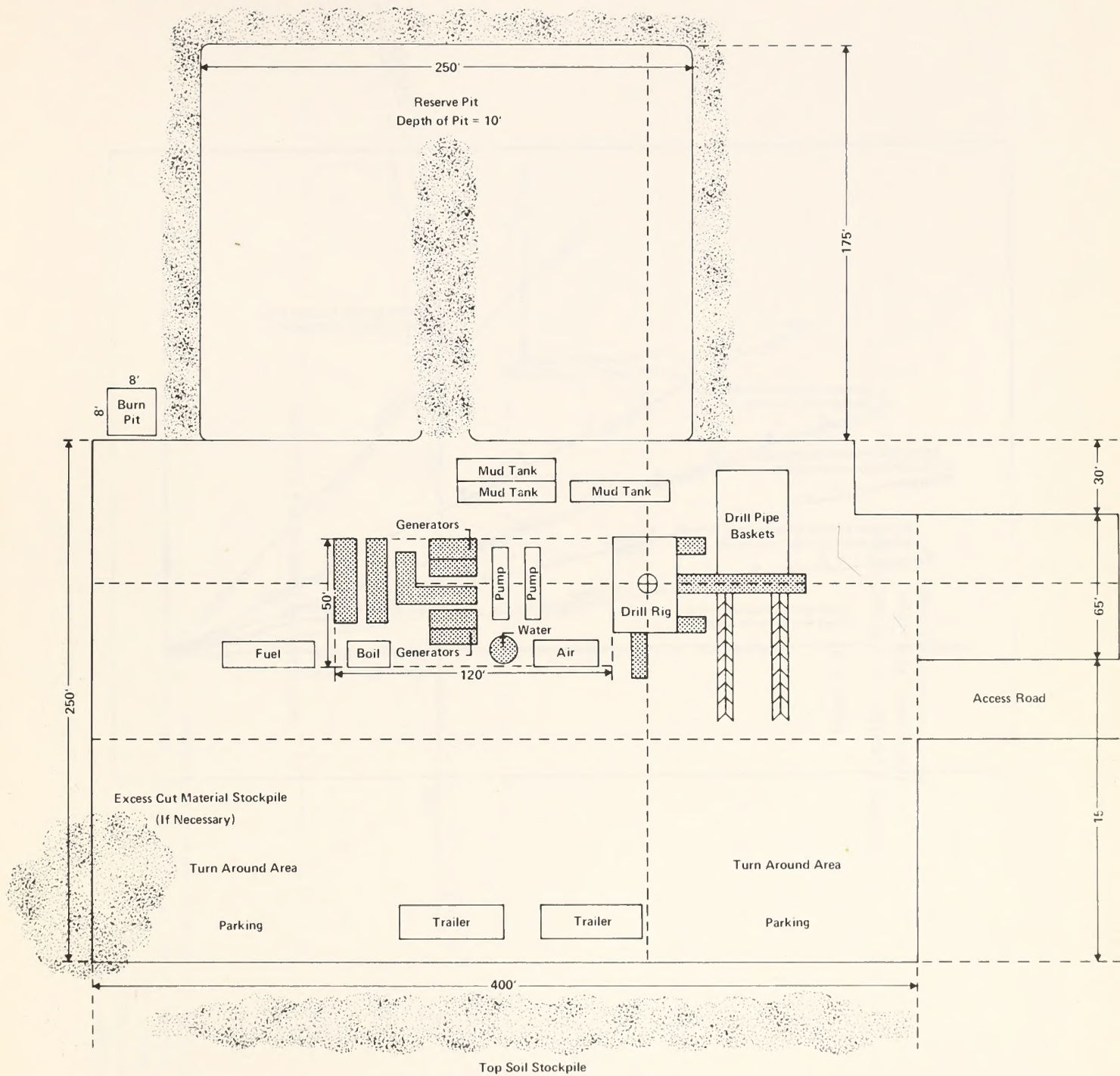


Figure 1 - 9

Location Layout For A Well 9,000 to 15,000 Feet Deep



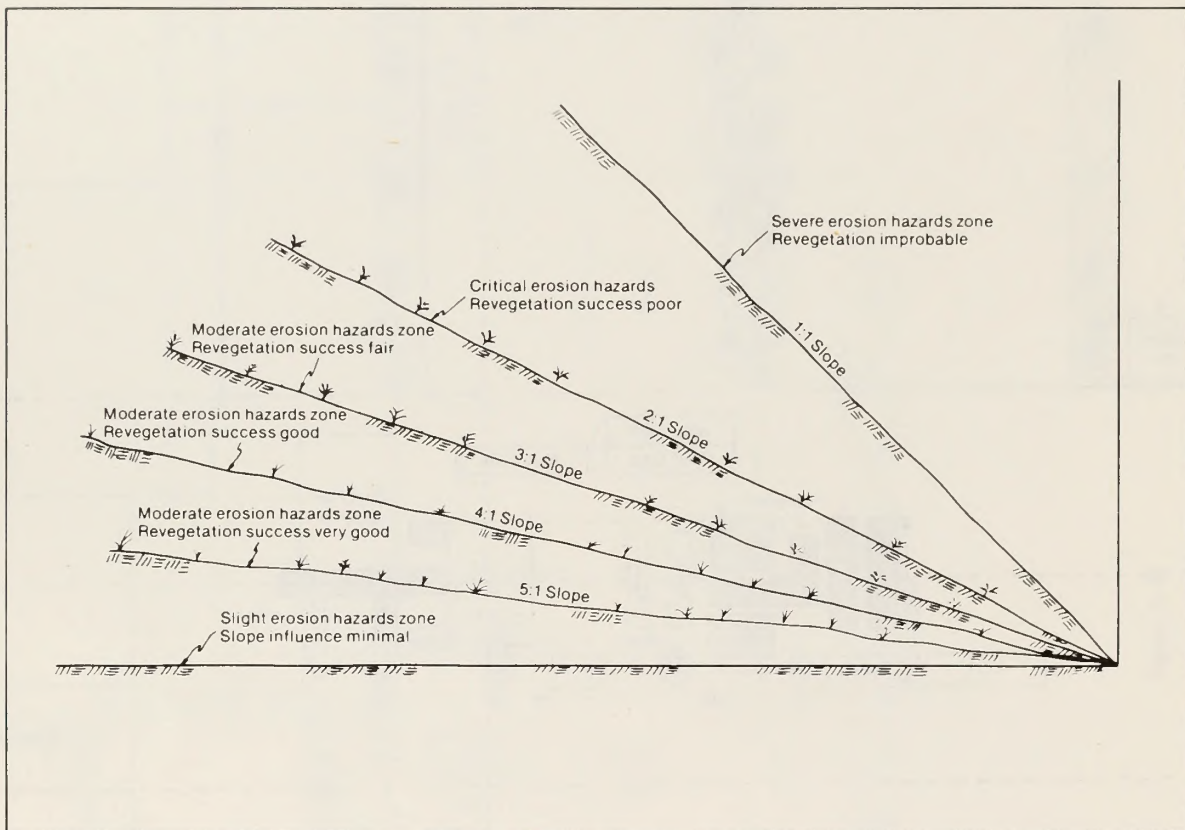
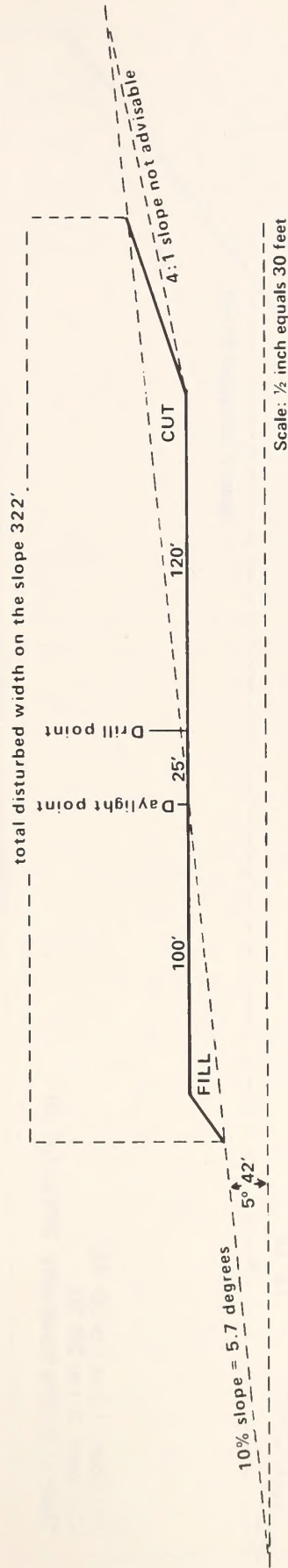


Figure 1 - 10

Influence of Percent Slope on Revegetation

If the slope is constant:

drilling platform and reserve pit length - 375'  
width not including the cut and fill slopes - 245'  
width including the cut and fill slopes - 322'  
area disturbed for the location including cut and fill slopes, platform, and reserve pit - 2.77 acres  
(Does not include area disturbed for cut and fill slopes on ends of location)



Fill slope - 1.5 to 1 or 35° 45'  
Cut slope - 3:1 or 18° 30'  
Slope of existing topography - 10% or 5° 42'

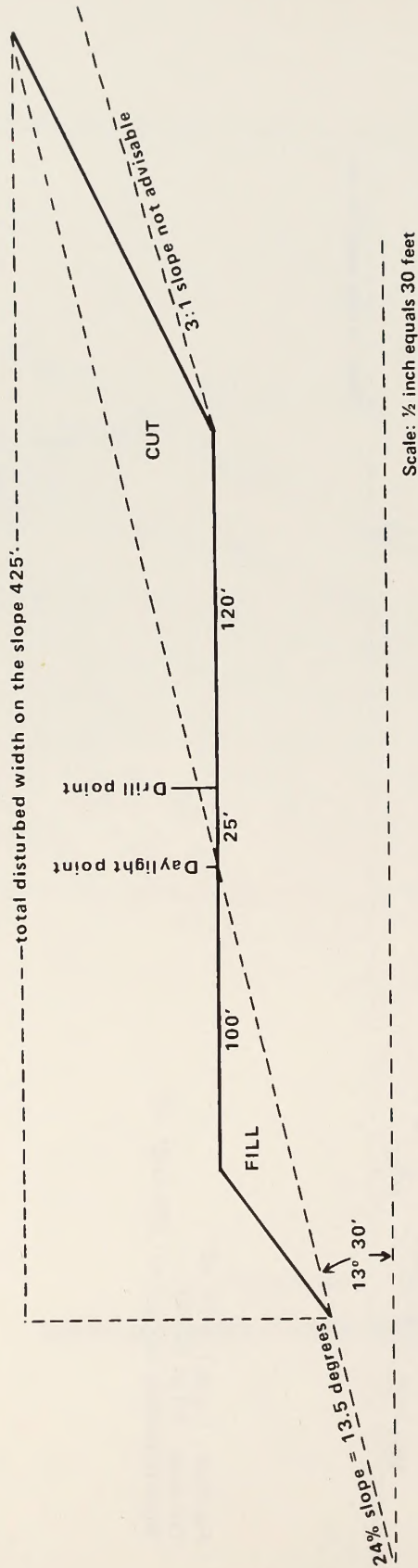
Figure 1 - 11  
Drilling Location on a Sidehill Cut  
Topography 10% Slope  
(Cross-section, end view)



If the slope is constant:

drilling platform and reserve pit length - 375'  
width not including cut and fill slopes - 245'  
width including cut and fill slopes - 425'

area disturbed for the location including cut and fill slopes, platform, and reserve pit - 3.66 acres  
(Does not include area disturbed for cut and fill slopes on ends of location)



Fill slope - 1.5 to 1 or 35° 45'

Cut slope - 2:1 or 26° 30'

Slope of existing topography - 24% or 13° 30'

Figure 1 - 12  
Drilling Location on a Sidehill Cut  
Topography 24% Slope  
(Cross-section, end view)

If the slope is constant:  
drilling location and reserve pit length - 375'  
width not including cut and fill slopes - 245'  
width including cut and fill slopes - 534'  
area disturbed for the location including cut and fill slopes on the ends of the location.)  
(Does not include area disturbed for cut and fill slopes on the ends of the location.)

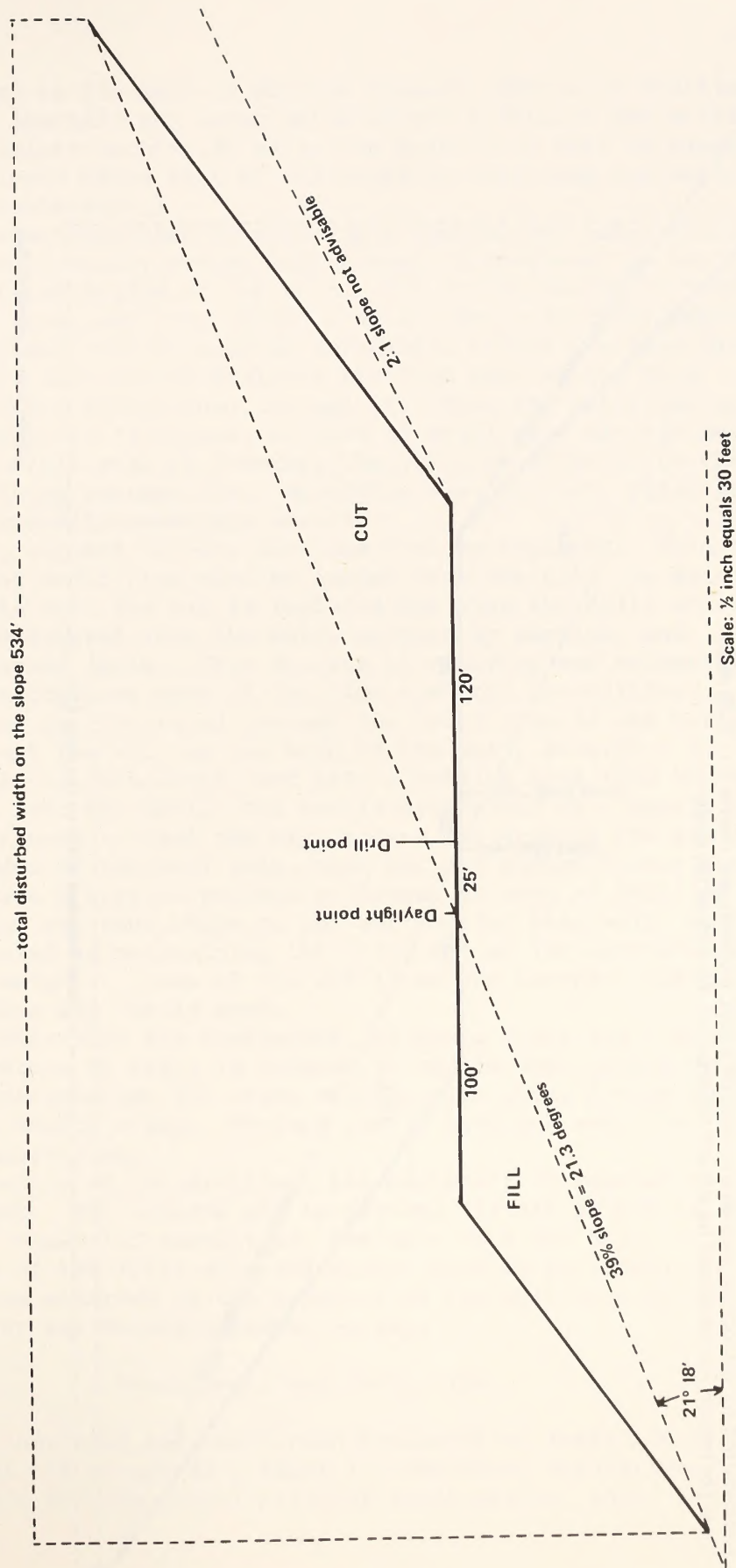


Figure 1 - 13  
**Drilling Location on a Sidehill Cut**  
Topography 39% Slope  
(Cross-section, end view)

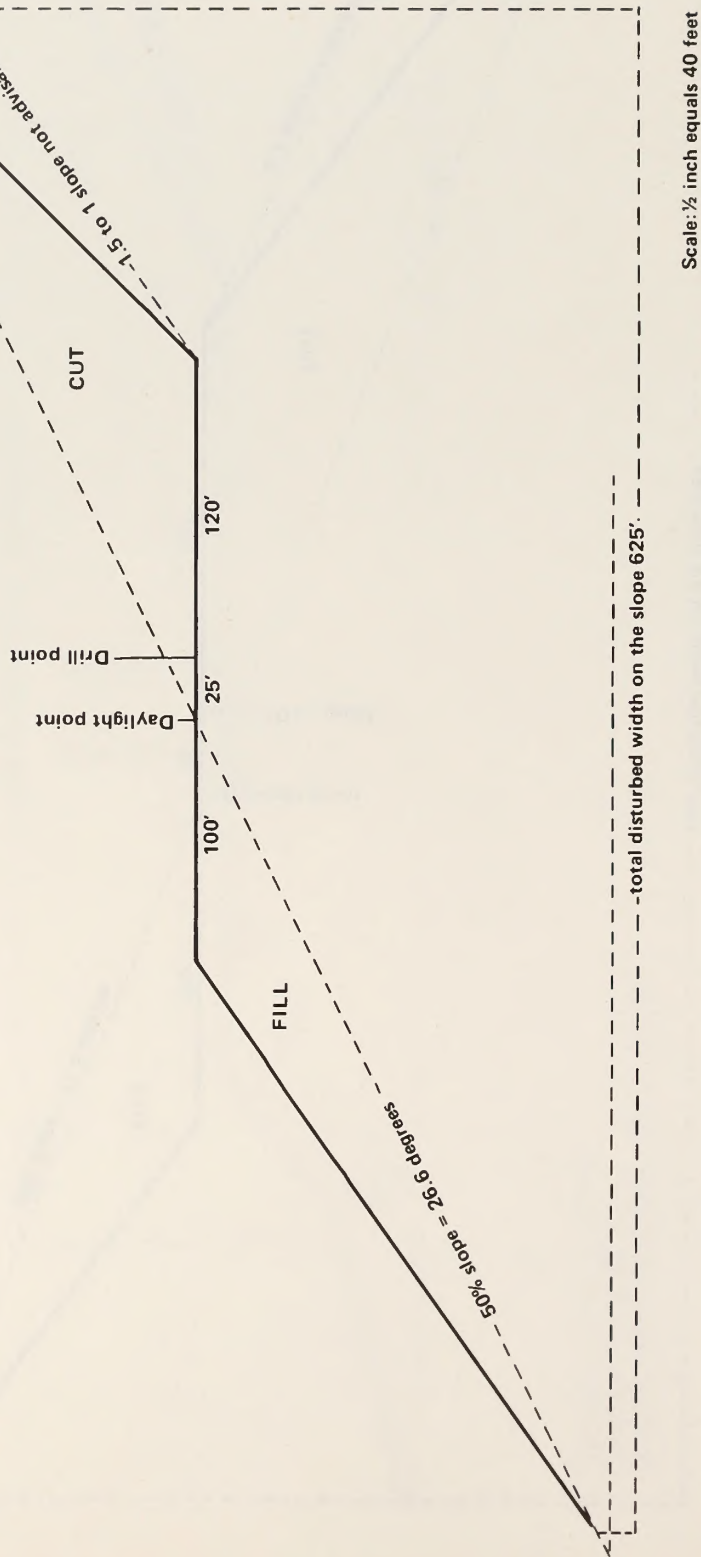
Fill slope - 1.5 to 1 or 35° 45'  
Cut slope - 1.5 to 1 or 35° 45'  
Slope of existing topography - 39% or 21° 18'



If the slope is constant:

drilling location and reserve pit length - 375'  
width not including cut and fill slopes - 245'  
width including cut and fill slopes - 625'

area disturbed for the location including cut and fill slopes, platform, and reserve pit - 5.38 acres  
(Does not include area disturbed for cut and fill slopes on the ends of the location)



Fill slope - 1.5 to 1 or 35° 45'  
Cut slope - 1.5 to 1 or 35° 45'  
Slope of existing topography - 50% or 26° 36'

Figure 1 - 14  
**Drilling Location on a Sidehill Cut**  
Topography 50% Slope  
(Cross-section, end view)

casing to be set as the well is drilled deeper. (Prior to drilling, operators must identify any water wells within 1 mile of the drill site. If any exists within .50 mile, the drill hole must be cased and cemented to a depth below that of the aquifers supplying the well(s) to prevent contamination.)

Drilling is accomplished by rotating a special bit under pressure. The combination of rotary motion and pressure causes rock to be chipped away at the bottom of the hole. The rotary motion is caused by a square or hexagonal rod, called a kelly, which fits through a square or hexagonal hole in a large turntable, called a rotary table. The rotary table sits on the drilling platform and, as the hole advances, the kelly slides down through it. When the kelly has gone as deep as it can, it is raised, a piece of drill pipe is attached in its place, the drill pipe is lowered, the kelly is attached to the top of it, and drilling recommences. By adding more and more drill pipe, the hole can steadily penetrate deeper.

Eventually, the bit becomes worn and must be replaced. Then the entire string of drill pipe must be pulled from the hole, in sections, until the bit is out. The bit is replaced and then the drill string is reassembled and lowered into the hole, section by section, and drilling is started again. This process of removing and reinserting the drilling string uses much of the time required in drilling.

Drilling mud is circulated through the drill pipe to the bottom of the hole, through the bit, up the bore of the well, through a screen which separates the rock chips, and into a holding tank from which it is pumped back into the well. The mud is maintained at a specific weight and thickness to cool the bit, reduce the drag of the drill pipe on the sides of the well hole, seal off any porous formation, contain formation fluids to prevent a blowout or loss of drilling fluid, and bring the rock chips to the surface for disposal. Various additives are used in maintaining the drill mud at the appropriate viscosity and weight. Some of the additives are caustic, toxic, or acidic, but these are rarely used.

Drilling operations are continuous, 24 hours a day and 7 days a week. The duration of drill is between 20 and 30 days unless drilling problems are encountered. The crews usually work three 8-hour shifts or two 12-hour shifts a day. Pickups and/or cars are used for workers' transportation.

Upon completion of the drilling, the equipment is removed to another location. The reserve pit is fenced. If oil or gas is not discovered in commercial quantities, the well is a dry hole. Rehabilitation of the drill site and access road is in accordance with the stipulations attached to the approval of the well site by the BLM (see Abandonment and Rehabilitation, below).

#### Development and Production

Wells are completed and production equipment is installed if it is determined that oil or gas is present in commercial quantities. Completion calls for the installation of steel casing, which is



cemented in, to provide stability and to protect specific underground zones. The casing is perforated into the zone or structure containing the oil or gas.

If the formation pressure is sufficient to raise oil to the surface, the well is completed as a flowing well. The equipment installed on the casing of a flowing well consists of various valves and pressure regulators which are used to control the oil or gas flow to production facilities.

Eventually, the reservoir pool tapped by a well becomes depleted so that the well requires a pump, even though it was a flowing well when first drilled. The majority of the productive wells drilled in the Buffalo Resource Area require pumps. Both pumpjacks and hydraulic pump units are used. Submersible pumps may be used in the deepest wells--over 11,000 feet. The majority of the pumps in the Buffalo Resource Area are pumpjacks of various sizes. The larger ones reach a height of 30 to 40 feet when at the top of the stroke.

Surface pumps are powered by internal combustion engines or electric motors. The engines may be either single cylinder or multi-cylinder. Fuel for the engines may be casinghead gas (the natural gas produced with the oil), if a sufficient quantity is present, or propane.

If produced oil contains water, it is separated before the oil is stored in a tank battery. The fluid is pumped or flows from the wellhead to a heater-treater through buried pipelines. Heater-treaters are of two types, horizontal and vertical. The maximum height of the former is 8 feet and of the latter is 28 feet. Selection of one type of heater-treater over another is based on space available at the location and/or company preference. Heat is applied to the heater-treater by the firebox (an integral part of the equipment) to break the emulsion. The heat is supplemented in most cases by chemicals. The oil is then pumped via pipeline to storage tanks, called the tank battery.

Wyoming law prohibits the flaring or venting of natural gas. Exceptions are allowed by the Wyoming Oil and Gas Commission (1) during testing of a new well or (2) when the amount of gas produced with the oil is so small that pipeline construction is not practical. Otherwise, if a well produces both oil and gas, provisions for shipping the gas must be made before oil production can continue.

Gas which occurs with the oil is separated by venting it out the top of the tank battery and into feeder lines leading to transportation lines. If enough casinghead gas is separated to make it economical for marketing, a plant may be constructed to remove the gasoline, butane, and propane, or a pipeline may be constructed to carry the product to an existing plant. There are eleven operating gas plants in Campbell County and one in Johnson County. If the volume of casinghead gas is insufficient to warrant treatment in a gas plant, it is usually used as fuel for pump engines in the field or as heating fuel for the heater-treaters. Gas is flared or vented into the atmosphere if it exceeds the fuel requirements on the lease but is not of commercial quantities.



Oil is then transported to a refinery or to a truck depot where it is unloaded into a pipeline leading to a large interstate pipeline. Trucks that transport the crude oil are large tank trucks, either semi- or truck and trailer.

The production equipment (heater-treater, holding facility for production water (if any is present), and tank battery) are either placed on a portion of the location (on cut rather than fill) or located a short distance from the wellhead along the access road. Production facilities are usually painted black, silver, or with company colors, unless otherwise specified. The heater-treater and tanks are surrounded by earthen dikes to contain accidental spills. Either all the facilities may be fenced, or only the production water pit may be fenced.

After an oil well has been placed in production, the unused portions of the drilling location are reshaped, the reserve pits are backfilled after they are dry, the topsoil material is redistributed, waterbars and diversions are constructed to prevent erosion, and the area is reseeded. Usually, the area around the wellhead and production facilities is surfaced with gravel or scoria to provide an all-weather work area. The access road is usually elevated and ditched. Culverts and permanent drainage crossings are installed. Portions or all of the access road may be surfaced to provide all-weather access.

#### Field Development

The most important factor in further development of an oil or gas field is the quantity of production. Other considerations are whether the field is on a lease basis or unitized, the probability of profitable production, the availability of drilling equipment, the necessity to protect a known geologic structure (KGS) from drainage by off-lease drilling, and the degree to which limits of the field are known.

When an oil or gas discovery is made, the Wyoming State Oil and Gas Conservation Commission assigns well spacing for the field. A well spacing pattern must be established before development drilling begins. Factors considered in the establishment of a spacing pattern include data from the discovery well concerning: porosity, permeability, pressure, composition, and depth of formations in the reservoir; well production rates and type (barrels of oil or cubic feet of gas); and the economic effect of the proposed spacing on recovery. In the Buffalo Resource Area, spacing for oil wells varies from 80 to 320 acres per well. Although there are no gas fields in the Buffalo Resource Area, it is anticipated the spacing would be from 320 to 640 acres per well, since that is the spacing assigned to gas fields in the other portions of Wyoming. An alternative spacing may be granted if the operator can show the different spacing is needed for maximum recovery and the state and federal agencies approve.

The procedures for obtaining approval to drill and for the drilling of development wells are generally the same as those for wildcat (exploration) wells.





Typical producing location, with all facilities at the location: tank battery (left), heater-treater (center), and pumpjack (right).

As more wells are placed in production, roads are improved by maintaining, surfacing with gravel or scoria, and installing drainage crossings. Mineral materials are usually purchased from local contractors and obtained from private sources. Materials that are obtained from areas of federally owned minerals require a sales contract and are processed through the Buffalo Resource Area.

Production from several wells on one lease may be carried by pipeline to a central tank battery. Use of a central tank battery depends on whether or not the oil is from the same formation, and whether or not the partners or stockholders are the same. If commercial quantities of gas are produced with the oil, feeder lines are constructed to carry it to transportation lines.

Surface use in an oil or gas field may be affected by unitization of the leaseholds. In areas of federally owned minerals, an exploratory unit is formed before a wildcat exploratory well is drilled. The boundary of the unit is based on geologic data. The developers of the unit can enter into an agreement to develop and operate as a unit, without regard to separate lease ownerships. Costs and benefits are allocated according to agreed terms.

Development in a unitized field may proceed more slowly than in a field composed of individual leases; in the former case, all owners within the participating area share in any well's production but in the latter, each lessee must drill his own well to obtain production.

Unitization reduces the surface use requirements because all wells are operated as though on a single lease. Duplication of field processing facilities is minimized, because development and operations are planned and conducted by a single operator. Often power lines are distributed throughout the unit and engines are converted to electric motor. Unitization may also involve wider spacing than otherwise, resulting in fewer wells. Access roads are usually shorter and better organized.

Many fields go through several development stages. A field may be considered fully developed and produce for several years, and then a well may be drilled to a deeper pay zone. Discovery of a new pay zone in an existing field is called a pool discovery, as distinguished from a new field discovery. A pool discovery may lead to the drilling of additional wells. Existing wells may also be drilled deeper.

A new stage of field development can lead to changes in locations of roads and facilities. All new construction, reconstruction, or alteration of existing facilities--including roads, dams, pits, flowlines, pipelines, tank batteries, or other production facilities--must be approved by the GS with surface protection input from the Casper District, Division of Operations, before work can commence.



As the productive life of a field progresses, problems arise such as erosion, unvegetated areas, washing out of drainage crossings and roads, plugging of culverts, deterioration of cattleguards, accumulation of derelict equipment, construction of unnecessary roads, unauthorized off-road cross-country travel, and improperly or unrehabilitated pipelines. The Casper District, Division of Operations, prepares rehabilitation plans to correct these problems and to return the field surface area to its original productivity. By adequately taking corrective action as problems arise, total rehabilitation can be accomplished within an acceptable time period after a field is completely exhausted.

### Secondary Recovery

Oil cannot be produced unless forces within the petroleum reservoir are great enough to drive the oil to the well bore. Primary production occurs when energy in the reservoir is sufficient to move the oil to the well. When energy sources within the formation are inadequate, secondary production methods are used, involving liquid or gas injection.

Presently, in the Buffalo Resource Area, the following number of oil fields are using some form of secondary recovery: Campbell County with 150 using water injection, Johnson County with 36 using water injection and 1 using gas injection, and Sheridan County with 1 using water injection.

On an average, successful water flooding doubles recovery of the resource.

The water used in water flooding is usually obtained by drilling a water well in the water flood area or reinjecting water that is recovered with the oil. Very little fresh water is used because it may form chemical bonds with the clays in some reservoir rocks and reduce the permeability of the reservoir formation. Chemicals may be added to the water to aid in releasing any oil that may cling to the reservoir rocks.

As a rule, the producing oil wells on the outer edges of a formation are converted to injection wells. As the need arises, injection wells are drilled or newly drilled oil wells that are not productive are used for the water flooding if they are in the proper location. Liquid or gas that is injected into the formation to aid in second recovery is carried to the injection wells by buried pipeline.

### Water Disposal

Excess water produced with the oil or as a result of water flooding must be disposed of. Although most produced waters are brackish to highly saline, some are fresh enough for beneficial use. The fresh water is discharged into drainages and is eventually mixed with surface water. Surface owners and public land grazing lessees may obtain fresh water that is discharged from oil fields and use it for agricultural purposes. Water discharge must meet standards of, and be permitted by, the Wyoming Department of Environmental Quality. To aid in the purification of the water, oil skimmer pits are often



established between the separating facilities and the surface discharge point.

Saltwater is usually disposed of underground, usually by introduction into a formation containing water of equal or poorer quality. In some fields, dry holes or depleted producing wells are used as disposal wells. Occasionally, new wells are drilled for disposal purposes. In the Buffalo Resource Area, there are eighteen water disposal systems in Campbell County, four in Johnson County, and one in Sheridan County.

If produced saltwater amounts to less than 50 barrels per day, it may be disposed of in lined evaporation pits with leak-detection systems.

#### Abandonment and Rehabilitation

The depletion of an oil field is a gradual progression. Outlying wells are abandoned and the field gets progressively smaller until the total original field is abandoned. Roads that are not necessary for efficient management of the land are obliterated and rehabilitated. Surface pipelines and power lines are removed. Buried pipelines are left in place.

At times, the abandonment of a single producing well is the same as the abandonment of a field. (In the Buffalo Resource Area, there are occasions when a single well makes up the total field.) Presently, each well is considered as an individual when abandoned and no field is abandoned as a unit.

Abandonment of a once-productive well and a dry hole is similar. When the decision is made to dry hole a well or to take it out of production, a concrete plug is installed at the bottom of the casing, the casing is filled with heavy mud, and a concrete cap is installed on top. In uncultivated areas, a marker pipe may be installed on top of the plugged drill pipe, extending 4 feet above ground and giving the legal description. However, Wyoming BLM's preference is that wells be capped at the ground surface, or, in agricultural areas, that the casing be cut off and capped below plow depth, and that no dry-hole marker be installed. Usually, one truck can haul enough concrete to plug an abandoned well.

If a once-productive well is being abandoned, the pumpjack, storage tanks, sheds, and anchors are removed. The concrete pad (to which the pumpjack was attached) is usually buried.

(Upon abandonment, a well useful as a water producer may be acquired by the surface owner from the oil or gas operator. In this case, the well is plugged below the water-bearing formation and then completed as a water well.)

Complete rehabilitation of the drill site is governed by the length of time it takes for the reserve or production pit to dry.



The drying time depends on the soil texture and the amount of water remaining in the pit. Pits constructed in porous material may be dry in less than 1 month, while those constructed in clay may require as long as 1 or 2 years to become dry enough to backfill. While the operator is waiting for a wet pit to dry, a portion of the location may be reshaped. Reseeding is postponed until the entire location and pit have been reshaped; this may require that the disturbed areas be open and susceptible to erosion for several years.

An alternative to waiting for reserve pits to dry has been agreed upon by BLM and GS to hasten rehabilitation. If water in the reserve pits is of suitable quality, and if surface disposal is approved by DEQ, the fluid may be drained onto adjacent vegetation or into a natural drainage. DEQ considers the following factors before allowing surface discharge: results of a complete chemical analysis of the fluid, the proposed discharge quantity and location, and the landowner's preference.

Theoretically, if the water quality is too poor for surface disposal, the reserve pit contents can be pumped out and trucked to an appropriate disposal site. This disposal method has not been used in the resource area, because there are no approved disposal sites (personal communication, Dave Farrel, GS, April 18, 1980).

The amount of times equipment is transported to and from the abandoned well site depends upon the drying time for the pit. Equipment used for rehabilitating the location and access road includes dozers (track-mounted and rubber-tired), scrapers, and motor graders. Work on steep topography may require use of drag lines.

The location is reshaped to approximately the original contour. For a dryhole location, this requires moving the soil material back uphill to its original position and redistributing the topsoil. For a once-productive well location, two situations may occur. (1) On privately owned surface, a location that is well vegetated and required a small cut (8 feet or less) is usually not disturbed or reshaped. (2) A location on private surface which required a large cut, and any location on federally owned surface is reshaped to blend with the surrounding topography. All topsoil on the area to be reshaped is removed and the fill material in the outside edge of the location is pushed back onto the cut portion of the location. The topsoil is then evenly redistributed.

Proper seedbed preparation can greatly influence vegetation establishment. "The ideal seedbed for range seeding is (1) very firm below seeding depth, (2) well pulverized and mellow on top, (3) not cloddy or puddled, (4) free from live resident plant competition, (5) free of seed of competitive species, and (6) has moderate amounts of mulch or plant residue on the soil surface" (Vallentine 1971).

BLM requires that topsoil be evenly distributed over the site and the seedbed prepared by disking to a depth of 4 to 6 inches, following the contour. Firm seedbeds hold moisture near the surface, help control depth of seeding, and provide anchorage for seedling roots. Rolling before drilling improves seed placement and seedling emergence



(Hyder 1961 and 1955). By allowing soil to remain undisturbed a few weeks before planting, particularly when accompanied by rainfall, some natural packing of the soil can result.

Waterbars or terraces are constructed on the reshaped location to prevent erosion. The disturbed area is then reseeded.

The success of vegetative recovery depends on site-specific seed mixtures and rehabilitation techniques. For example, sandy sites require the use of species which establish readily and are tolerant to such soil conditions. Sandy sites are susceptible to wind erosion. Mulching and netting may be required under such conditions. Packing small ridges in sandy soils has also been found useful in stopping wind erosion (Hyder 1970 and Marlatt 1970). Increased seeding rates are also suggested for poor seedbeds (Vallentine 1971). Steep, critical sites may require mulching or netting to hold soils and seeds in place until seedlings have become established. The use of jute netting or straw mulch held in place by wire netting can increase grass seedling establishment six times or more. Such techniques can cost up to \$1,500 per acre or more (Vallentine, 1971).

Seed mixtures for the Buffalo Resource Area are shown on Map N, Appendix. The mixtures were derived from consideration of geographic conditions, elevation, precipitation, and soil type.

BLM currently limits seeding to the periods of September or October and April or May. In addition to seeding in the spring or fall, every effort should be made to seed reasonably soon after seedbed preparation. If left unseeded for one growing season, the site may be occupied by competitive resident species or noxious weeds.

The destruction of seedlings by livestock interferes with successful rehabilitation. Seed mixtures are basically developed for the production of livestock forage, consisting mostly of grasses. Livestock concentrate their grazing on such seeded areas and ignore adjacent available native forage. Vallentine (1971) recommends that grazing of seeded sites should not begin until after the plants have become established, usually following the second full growing season. Fencing rehabilitated sites may be required to prevent grazing. This stipulation has been attached to several newly issued oil and gas leases. It should also be made standard procedure on privately owned surface, especially on those lands which support sheep. The fencing of access road and pipelines is not practical because of their length and problems caused by a fence dissecting the range. Fencing problem points on steep slopes or in sandy areas is a possibility, depending on the specific situation.

Access roads are reshaped and reseeded in a manner similar to that employed in reclaiming well locations, unless a private landowner requests they be left in place.

Compliance inspections are periodically conducted by BLM to check the progress of the rehabilitation. Final abandonment is not approved until vegetation has been reestablished to the satisfaction of the Casper District, Division of Operations, and GS. On privately owned surface, the landowner must be consulted concerning his satisfaction with the rehabilitated areas.



If a company's rehabilitation efforts are consistently unsuccessful (or lacking), BLM ususally notifies the company of its intent to pull the company's performance bond. If this is not effective, BLM contacts GS, which sends a letter of warning to the company. This usually brings action from the company. If not, BLM issues a rehabilitation work contract, then presents the bill to Wyoming State Office, which obtains payment from the bonding company. The problem with this approach is the unrehabilitated area is out of production and exposed to accelerated erosion for at least 3 years before rehabilitation is even started.

A solution would be to pull the bonds sooner and establish the importance of rehabilitation.

#### Issuance of Rights-of-Way

Rights-of-way are required for all facilities, tank batteries, pipelines, truck depots, power lines, and access roads that occupy federally owned land outside the lease (By the end of 1980, Wyoming BLM will implement the regulations requiring a lessee to obtain a on right-of-way for any facility, on or off the lease.) When a third party (someone other than the oil or gas company and the federal government) constructs a facility or installation on or off the lease, a right-of-way is also required. The rights-of-way are processed through the Wyoming State Office by the Buffalo Resource Area. All actions of a temporary nature (less than 1 year in duration) are processed directly through the Buffalo Resource Area.

When a company determines a right-of-way is needed, they contact the resource area and request a meeting on the ground with the realty specialist to determine the most suitable route. Both private and public lands are examined. The companies have been very cooperative, as many times this has benefited both parties in construction time and money.

If any drainages or steep slopes are to be crossed, or any significant soil disturbance is going to occur, the best methods of construction and mitigation are discussed at the meeting and agreed upon before the case is processed. The company is reminded an archeological clearance must be obtained before a grant may be issued.

The company then has a survey plat prepared which is submitted to the BLM Wyoming State Office along with their application. After the case has been adjudicated in the state office, the case is submitted to the resource area for final processing. The most significant action at this point is preparing stipulations for the grant. Areas of critical concern are identified in the stipulations by citing the station as given on the survey plat so the contractor and grantee will know exactly what is required at any given point. For example, companies have advised the resource area staff that most of their people have no knowledge of waterbar placement. Therefore, specifically identifying stations helps alleviate this problem.

If construction is considered major, a preconstruction meeting is held with the BLM Casper District, Division of Operations.



Following are descriptions of the transportation and communication rights-of-way associated with oil and gas development and sample construction methods.

Standard stipulations for rights-of-way have been established for the entire state by the BLM Wyoming State Office (WY-80-155, February 7, 1980).

#### Transmission Pipelines

Gathering pipelines collect oil and gas from diverse sources within an oil and gas field and then converge into a transmission pipeline or trunk line that transports the aggregated product to a refinery or other major collection point. From there, distribution pipelines deliver to individual consumers.

A pipeline system includes the pipe, pump and compressor stations, and electrical and communication systems. All these facilities lie within the right-of-way, which is usually 50 feet wide except at pump and compressor stations, which occupy approximately 4 acres each (see Figure 1-15). Pump stations are needed about every 30 miles and compressor stations every 185 miles.

The area actually needed for pipeline construction varies with the diameter of the pipe; but averages 25 feet in width. Typical pipeline construction procedures are shown in Figure 1-16. Construction equipment used includes a cat, ditching machine, side boom, backhoe, taping machine, welding trucks and various hand tools. Usually a 12-foot width of the right-of-way is leveled by removing a minimum amount of topsoil. The topsoil is stockpiled for use in rehabilitation. An additional area of about 10 feet is bladed to allow passage of trucks, weeders, and wrapping machines. In areas where it is relatively flat and there is no danger of fire hazard, there is no clearing done. Draws are spanned to prevent erosion problems. The ditching machine makes a cut 2 feet wide and 3 to 4 feet deep. The steel pipe is welded, doped, taped, lowered into the ditch, and backfilled with 30 inches of dirt. All pipe is treated to prevent corrosion, and if breaks occur it is usually due to mishandling. Topsoil is redistributed and seeded.

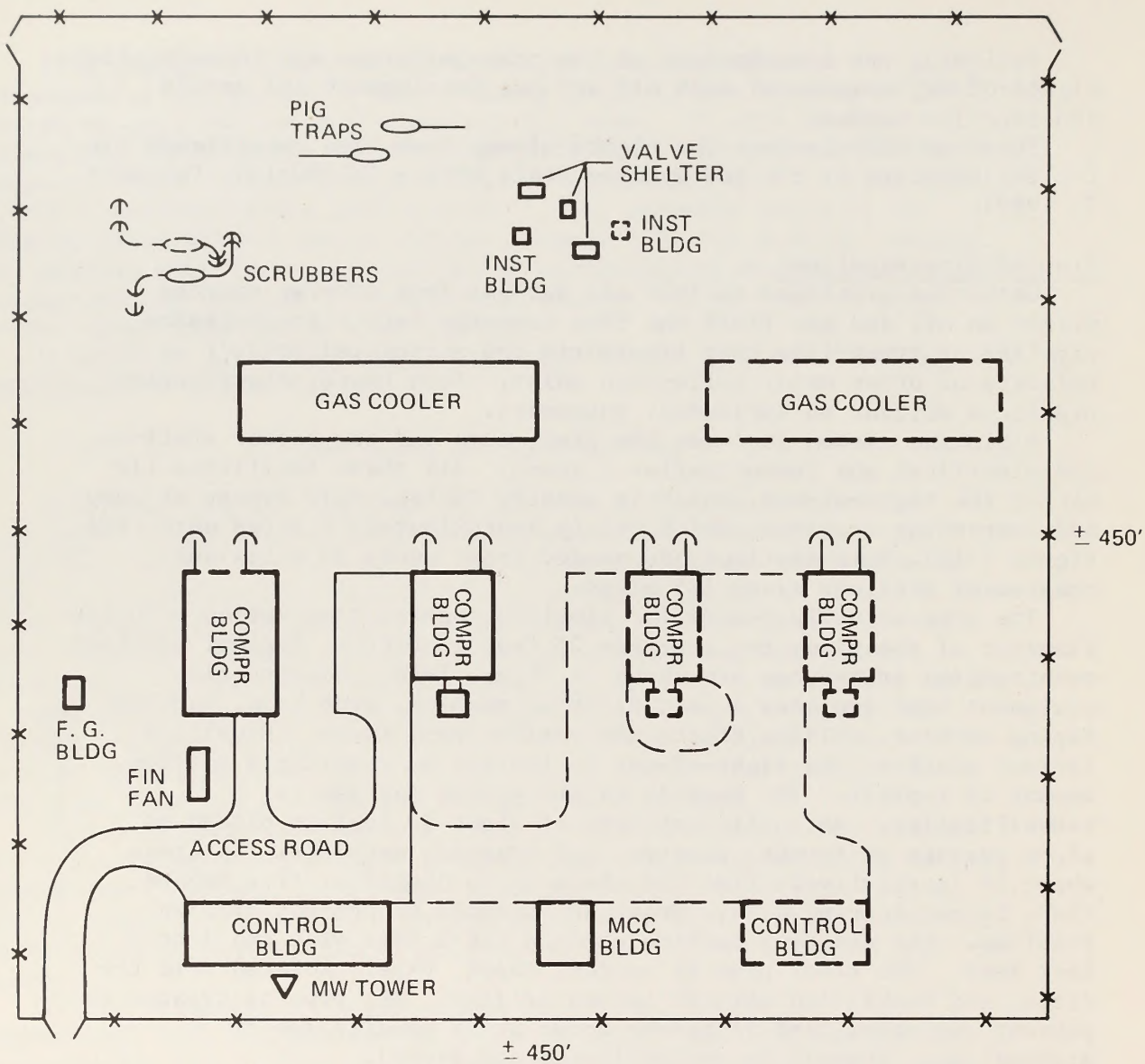
After construction, a 20- or 30-foot width track along the pipeline is required for maintenance.

All construction, maintenance and operation of pipelines is performed accordance with the minimum Federal Safety Standards for Liquid Pipeline, Part 195, Title 40, Code of Federal Regulations; appropriate BLM standard stipulations; and special stipulations determined necessary at the time of the field inspection (see Chapter 3, Table 3-1).

#### Electric Transmission Lines

Transmission lines considered in this environmental assessment are relatively small lines (69 kV and less) on single wood poles in narrow rights-of-way. Average span lengths for single-pole wood structures are 250 to 400 feet. Average span lengths occur only where the ground profile is relatively level. Crossing a rounded ridge may require several structures, while a sharp ridge may only require one. Long spans are needed to cross deep draws and valleys.

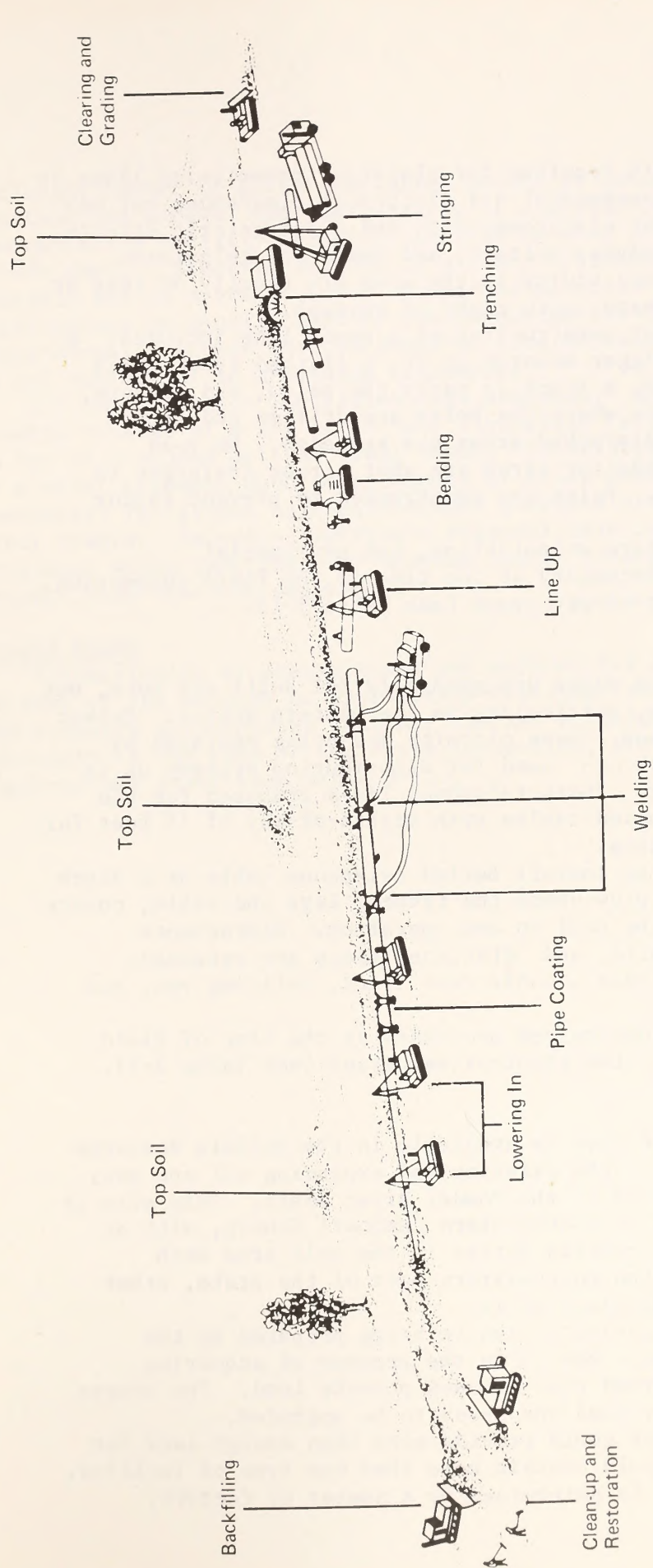




ALBERTA-CALIFORNIA ENVIRONMENTAL REPORT 1975

Figure 1 - 15

Typical Compressor Station



(Scale Condensed for Illustration Purposes)  
The Aerospace Corporation 1975

Figure 1 - 16

## Typical Pipeline Construction Spread



The right-of-way width required for electric transmission lines is basically determined by mechanical and electrical clearances but may involve considerations for electromagnetic and electrostatic effects such as audible noise, induces voltage, and radio and television interference. Right-of-way widths in the area are usually 50 feet or less, and terms are 30 years, with right of renewal.

Equipment required for construction of a power line includes: a truck with a post-hole digger mounted on it, a flatbed truck which carries the reels of wire, a truck to carry the poles, and pickups. Surface disturbance occurs where the holes are drilled and from vehicle travel, and all disturbed areas are reseeded. No road building is allowed. Conductor wires are shot across drainages to prevent soil disturbance. Poles are constructed to prevent raptor electrocution.

Appropriate WSO standard stipulations, and any special stipulations determined necessary at the time of the field inspection, are attached to the right-of-way grant (see Table 3-1).

#### Communication Lines

Overhead communication wires are generally not built any more, but a number are still in use, particularly in the western states. Except for railroad communications, these circuits are being replaced by buried paired cables which are used for distribution systems up to about 250 miles in length. Those telephone lines proposed for the resource area would be buried cables with rights-of-way of 16 feet for 30 years with renewal rights.

A cable plow is used to install buried telephone cable at a depth of 30 inches. The cable plow opens the trench, lays the cable, covers the cable, and compacts the soil in one operation. Disturbance amounts to .12 acre per mile, and disturbed areas are reseeded. Other equipment used includes a cable reel truck, splicing van, and pickups.

Special stipulations determined necessary at the time of field inspection are attached to the right-of-way grant (see Table 3-1).

#### Communication Sites

One communication site area is available in the Buffalo Resource Area to provide services to the existing and expanding oil and gas, coal, and uranium industries in the Powder River Basin. This site is located on Pumpkin Buttes in southwestern Campbell County, with an elevation of 6,000 feet. Pumpkin Buttes is the only area with significant elevation in the northeastern part of the state, other than the Big Horns and the Black Hills.

A communication site activity plan is being prepared by the resource area at this time. BLM is in the process of acquiring easements for the access road that crosses private land. The access road is not an all-weather road and needs to be upgraded.

The Pumpkin Buttes site could provide more than enough land for any number of sites and could contain more than one type of facility. The multiple use of sites is determined by a number of factors,

including number of sites available, potential demand for sites, location and access, and availability of electric power. A communication facility normally requires an area of 2,500 to 10,000 square feet. Electric service is already available from Tri-County Electric and is provided under a separate permit. The service road right-of-way is usually part of the communication facility right-of-way. Access must be acquired from private landowners if BLM is not successful in obtaining easements.

All communication facilities have antennas. Radio antennas usually consist of a 20- to 30-foot fiberglass reinforced whip mounted on top of a wooden pole or steel tower. Television antennas consist of a metal gridwork mounted on wooden or steel poles, and larger commercial facilities have dish-shaped antennas atop wooden poles or steel towers. Telephone microwave stations have large dish-shaped antennas, which sometimes are mounted inside fiberglass domes to protect them from the weather.

#### Access Roads

A description of access roads and methods for their construction is part of the section on exploratory drilling, above. Appropriate WSO standard stipulations and any special stipulations determined necessary at the time of the field inspection, are attached to the right-of-way grant (see Table 3-1).





## CHAPTER 2 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

### INTRODUCTION

This chapter of the environmental assessment describes both the impacts of oil and gas activity and the resources being affected. The purpose of using this unconventional format is to focus attention on only those parts of the environment germane to the impact analysis.

### ASSUMPTIONS AND ANALYSIS GUIDELINES

1. Impacts of oil and gas activity are analyzed through 1990.
2. Reclamation of disturbed land is considered complete when the equipment has been removed, the disturbed land has been recontoured and revegetated, and the reclamation bond has been released. Reclamation requires an average of 3 years. Reclamation of a location or an access road is begun when the well is abandoned. Recontouring and reseeding of seismic exploration lines, utility lines, and pipelines usually begin after construction of the projects is completed.
3. Impacts lasting after reclamation is completed are considered long term.
4. Tables 2-1 through 2-4 summarize acreage and water requirements for various phases of oil and gas development, as well as anticipated land disturbance and water usage for oil and gas activity through 1990. A comparison of surface disturbance and water use for oil and gas development vs. that caused by other mineral and urban development in the resource area by 1990 can be found in the Final Environmental Statement on Eastern Powder River Basin Coal Resources (FES 79-17).
5. Since projections of oil and gas exploration and drilling activity are impossible to predict (personal communication, Terry Martin, Wyoming Petroleum Association, August 14, 1979, and Rick Marvel, Wyoming Oil and Gas Commission, August 1, 1979), we made the assumption that the number of wells drilled annually would not vary significantly between now and 1990. This assumption could be invalidated and drilling rates could either increase or decrease dramatically, depending on international crude prices and federal and state government policies.
6. It was further assumed that the oil and gas industry would decline in relative economic importance in the resource area, due primarily to the growth of the coal industry, and that the environmental impacts of oil and gas development would correspondingly decline in relative importance.



TABLE 2-1  
OIL AND GAS DEVELOPMENT DATA, ON FEDERAL OIL AND GAS ESTATE  
BUFFALO RESOURCE AREA

|                                                                                                                    | Present<br>(1979) | 1985 <sup>1</sup> | Increase <sup>2</sup> | 1990 <sup>1</sup> | Increase <sup>2</sup> |
|--------------------------------------------------------------------------------------------------------------------|-------------------|-------------------|-----------------------|-------------------|-----------------------|
| Number of miles of seismic exploration, annual                                                                     | 500               | 500               | 0                     | 500               | 0                     |
| Number of drilling/production locations, cumulative <sup>3</sup>                                                   | 1,437             | 2,355             | 918                   | 3,120             | 1,683                 |
| 0-10% slope (39% of total)                                                                                         | 560               | 918               | 358                   | 1,216             | 656                   |
| 11-24% slope (35% of total)                                                                                        | 503               | 824               | 321                   | 1,092             | 589                   |
| 25-39% slope (23% of total)                                                                                        | 330               | 542               | 212                   | 718               | 388                   |
| 40%+ slope (37% of total)                                                                                          | 44                | 71                | 27                    | 94                | 50                    |
| Number of miles of access road, cumulative <sup>3,4</sup>                                                          | 1,208             | 1,979             | 771                   | 2,621             | 1,413                 |
| 0-10% slope (39% of total)                                                                                         | 471               | 772               | 301                   | 1,022             | 551                   |
| 11-24% slope (35% of total)                                                                                        | 423               | 693               | 270                   | 917               | 494                   |
| 25-39% slope (23% of total)                                                                                        | 278               | 455               | 177                   | 603               | 325                   |
| 40%+ slope (37% of total)                                                                                          | 36                | 59                | 23                    | 79                | 43                    |
| Number of miles of power line, cumulative,<br>distribution lines only <sup>5</sup>                                 | 86                | 111               | 25                    | 132               | 46                    |
| Number of miles of pipeline, cumulative <sup>6</sup>                                                               | 1,406             | 1,598             | 192                   | 1,758             | 252                   |
| Number of compressor stations, gas plants,<br>water disposal plants, cumulative                                    | 34                | 34                | 0                     | 34                | 0                     |
| Number of active mineral material sales sites<br>for oil and gas activity, on federal<br>minerals only, cumulative | 7                 | 10                | 3                     | 10                | 3                     |
| Population increase attributable to oil and<br>gas employment                                                      | 0                 | 0                 | 0                     | 0                 | 0                     |

Note: Data based on assumptions and analysis guidelines, above.

- 1 Assuming exploratory drilling rate remains at the present rate (see Table 1-4), then an average of 153 wells would be drilled annually on federal oil and gas estate.
- 2 Increase over the number existing in 1979.
- 3 Slope classes are taken from the Buffalo Resource Area Unit Resource Analysis, overlay 1605.32B, on file at the Buffalo Resource Area BLM Office. See Table A-1 in the Appendix for a slope conversion chart.
- 4 Assuming 1.5 miles of access road are required per wildcat well, and 0.5 mile per well in a field. About 34% of the wells drilled annually in the resource area are wildcats (see Table 1-4).
- 5 Assuming that 8% of producing wells are electrified (personal communication, Glen Blakely, Inexco, August 13, 1979) and that each well requires .75 mile of power line. About 45% of the wells drilled each year are producers (see Table 1-4).
- 6 Based on Buffalo Resource Area Unit Resource Analysis, assuming that 10% of the wildcat wells and 90% of the unitized field wells have pipelines, with .75 mile pipeline for each well.
- 7 Since the rate of exploratory drilling is postulated to remain at present levels, no increase in oil and gas industry employment is anticipated.

TABLE 2-2

## ACREAGE REQUIREMENTS FOR OIL AND GAS ACTIVITIES

|                                                        |                         |
|--------------------------------------------------------|-------------------------|
| Seismic exploration                                    | 1.6 acres per mile      |
| Drilling/production location*                          |                         |
| 0-10% slope                                            | 2.77 acres per location |
| 11%-24% slope                                          | 3.66 acres per location |
| 25%-39% slope                                          | 4.46 acres per location |
| 40%+ slope                                             | 5.38 acres per location |
| Access road*                                           |                         |
| 0-10% slope                                            | 2.28 acres per mile     |
| 11%-24% slope                                          | 3.12 acres per mile     |
| 25%-39% slope                                          | 5.00 acres per mile     |
| 40%+ slope                                             | 8.68 acres per mile     |
| Power line**                                           | 2.4 acres per mile      |
| Pipeline**                                             | 2.4 acres per mile      |
| Compressor station, gas plant,<br>water disposal plant | 5 acres per plant       |
| Mineral material sale                                  | 3 acres per sale        |

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\* Derived from Megahan 1976. For access roads, the disturbance necessary to make a 16-foot-wide driving surface. See Table A-1 in the Appendix for a slope conversion chart.

\*\* Assuming a 20-foot swath of disturbance within a 50-foot right-of-way.



TABLE 2-3  
CUMULATIVE ACREAGE DISTURBED AND RECLAIMED FOR OIL AND GAS ACTIVITY  
Federal Oil and Gas Estate  
Buffalo Resource Area

| <u>Acreage Disturbed</u>                                          | <u>Present<br/>(1979)</u> | <u>1985</u> | <u>1990</u> |
|-------------------------------------------------------------------|---------------------------|-------------|-------------|
| Seismic exploration, annual                                       | 800                       | 800         | 800         |
| Drilling/production locations                                     |                           |             |             |
| 0 -10% slope                                                      | 1,551                     | 2,543       | 3,368       |
| 11%-24% slope                                                     | 1,841                     | 3,016       | 3,997       |
| 25%-39% slope                                                     | 1,472                     | 2,417       | 3,202       |
| 40%+ slope                                                        | 237                       | 382         | 506         |
| Subtotal                                                          | 5,101                     | 8,358       | 11,073      |
| Access road                                                       |                           |             |             |
| 0 -10% slope                                                      | 1,074                     | 1,760       | 2,330       |
| 11%-24% slope                                                     | 1,320                     | 2,162       | 2,861       |
| 25%-39% slope                                                     | 1,390                     | 2,275       | 3,015       |
| 40%+ slope                                                        | 312                       | 512         | 686         |
| Subtotal                                                          | 4,096                     | 6,709       | 8,892       |
| Power lines                                                       | 206                       | 266         | 317         |
| Pipelines                                                         | 3,374                     | 3,835       | 4,219       |
| Gas plants, compressor stations,<br>water disposal plants         | 170                       | 170         | 170         |
| Mineral material sales                                            | 21                        | 30          | 30          |
| TOTAL                                                             | 13,768                    | 20,168      | 25,501      |
| <u>Acreage Reclaimed</u>                                          |                           |             |             |
| Seismic exploration, annual                                       | 800                       | 800         | 800         |
| Drilling/production locations*                                    | 0                         | 1,530       | 3,022       |
| Access roads*                                                     | 0                         | 1,231       | 2,434       |
| Power lines**                                                     | 0                         | 0           | 0           |
| Pipelines***                                                      | 3,126                     | 3,605       | 3,989       |
| Gas plants, compressor stations,<br>water disposal plants         | 0                         | 0           | 0           |
| Mineral material sales                                            | 0                         | 0           | 0           |
| TOTAL                                                             | 3,926                     | 7,166       | 10,245      |
| <u>Difference Between Acreage Disturbed<br/>    and Reclaimed</u> | 9,842                     | 13,002      | 15,256      |

Note: See Table A-1 in the Appendix for a slope conversion chart.

Data in Table 2-3 based on assumptions and analysis guidelines, above.

\* Based on the number of dry holes drilled each year, assuming 3 years for reclamation and the same proportion of slope classes shown under acreage disturbed. Wells shown in 1979 are either producers or were drilled in 1978 or 1979, so no rehabilitation has been completed.

\*\* Power lines are constructed to producing wells only, and interruption of visual resources and other land uses continues as long as the line is in place.

\*\*\* Assuming 3 years for reclamation.

TABLE 2-4

WATER REQUIREMENTS FOR OIL AND GAS ACTIVITIES

|            |                                                                                                                                                |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| Drilling   | 1 acre-foot per 3,000 feet of depth drilled*                                                                                                   |
|            | Annual water usage for drilling is approximately 434 acre-feet** for wells drilled on federal oil and gas estate in the Buffalo Resource Area. |
| Production | After the well is drilled, there is usually no water needed.                                                                                   |

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\* Personal communication, O. M. McCoy, Geological Survey, February 23, 1979.

\*\* Average well depth in the resource area is 8,500 feet. If energy demand and oil prices warrant, the average depth could increase to 15,000 or 20,000 feet.



## AFFECTED ENVIRONMENT AND IMPACTS OF THE PROPOSED ACTION

### Climate

The climate of the resource area is not affected by oil and gas activity. However, climate influences other resources, such as air quality, soils, and vegetation, and hence the degree of impact resulting from oil and gas activity. Climatic factors important to the understanding of impacts on other resources are discussed in the respective sections, below. A description of the climate in northeast Wyoming is given in the Final Environmental Statement on Eastern Powder River Basin Coal Resources (FES 79-17).

## Air Quality

Air quality in the Buffalo Resource Area is considered good, well within the federal and state air quality standards (Tables 2-5 and 2-6). The presence of particulate matter (dust and smoke) and gaseous pollutants in the air affects regional air quality. Air quality degradation is localized, and most noticeable at bentonite mines in southwestern Johnson County, the Wyodak Power Plant east of Gillette, coal mines along the Wyodak seam from north of Gillette to southern Campbell County, the Big Horn and Decker mines north of Sheridan, an occasional sump fire at scattered oil fields, and the cities of Sheridan and Gillette. (Additional information about present and future air quality in northeast Wyoming, particularly Campbell County, is given in the Final Environmental Statement on Eastern Powder River Basin Coal Resources (FES 79-17).)

Oil and gas activities affect air quality through the production of dust, vehicle emissions, and gaseous emissions from petroleum products. These impacts are restricted to oil fields and their access roads and probably do not affect pollutant concentrations over the entire resource area. Furthermore, air pollution from oil and gas activity is so localized as to be unobjectionable unless it occurs within or near residential areas (see socioeconomics section of this chapter).

Hydrogen sulfide, a poisonous gas often produced with oil, does not presently occur in the resource area in dangerous amounts. A disturbing odor, the sulfur component of the hydrogen sulfide, is present at the Cellar's Ranch Oil Field northwest of Kaycee and at an Atlantic Richfield oil field west of Rozet. Hydrogen sulfide is most likely to occur in the Minnelusa Formation (see Figure 1-4) and formations below it (personal communication, Glen Worden, Geological Survey, November 19, 1979). Few producing wells in the resource area are deeper than the Minnelusa Formation; as deeper formations are explored in the future, hydrogen sulfide may become a problem.

Dust and vehicle and gaseous emissions vary with the stages of oil and gas activity.

The dust produced during geophysical exploration is minimal.

Dust produced during road and drill pad construction and the transporting of drilling equipment over an unpaved access road (approximately .5 pound per cubic yard of earth moved and 5 pounds per vehicle mile traveled, with virtually continuous travel) significantly increases particulate concentrations in the air (PEDCo 1978). Violations of the state standard of 60 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) for total suspended particulates may occur within 0.3 mile of an unpaved road (FES 79-17). A lesser impact is caused by the emissions from the internal combustion engines. These impacts last less than 1 month for each well.

In the production phase, use of the access road decreases to approximately one daily trip per well, and dust produced is minimal. Gaseous pollutants, such as carbon monoxide, hydrocarbons, nitrogen



TABLE 2-5

AIR QUALITY DATA FOR BUFFALO RESOURCE AREA  
(Micrograms per cubic meter)

| Monitor Location | Parameter                           | January 1977 |      | April 1977 |      | July 1977 |      | October 1977 |      |
|------------------|-------------------------------------|--------------|------|------------|------|-----------|------|--------------|------|
|                  |                                     | Max.         | Mean | Max.       | Mean | Max.      | Mean | Max.         | Mean |
| Buffalo          | Total Suspended Particulates (TSP)  | 4            | 2    | 27         | 13   | 25        | 19   | --           | --   |
| Gillette         | TSP                                 | --           | --   | --         | --   | 35        | 26   | --           | --   |
|                  | Nitrogen Dioxide (NO <sub>2</sub> ) | --           | --   | --         | --   | 6         | 3    | --           | --   |
|                  | Sulfur Dioxide (SO <sub>2</sub> )   | --           | --   | --         | --   | 1         | 0    | --           | --   |
| Pole Creek       | TSP                                 | 4            | 2    | 13         | 7    | 16        | 10   | 12           | 6    |
| Reno Junction    | TSP                                 | 29           | 10   | 27         | 20   | 87        | 44   | 29           | 12   |
| Sheridan         | TSP                                 | 20           | 12   | 35         | 24   | 33        | 28   | 67           | 36   |
| Story            | TSP                                 | 11           | 8    | 23         | 14   | 23        | 16   | --           | --   |

Source: Wyoming Department of Environmental Quality 1978.

Note: A 24-hour TSP concentration of 150 ug/m<sup>3</sup> was measured in Gillette in 1975, equaling the federal secondary and Wyoming ambient air quality standard. No other measurements of TSP or gaseous pollutants at these monitoring sites have approached the standards.

\* See Figure 2-1.

TABLE 2-6

## FEDERAL AND WYOMING AIR QUALITY STANDARDS

| Pollutant                           | Averaging Time      | Federal Primary Standards* |     | Federal Secondary Standards* |     | Wyoming State Standards** |     |
|-------------------------------------|---------------------|----------------------------|-----|------------------------------|-----|---------------------------|-----|
|                                     |                     | ug/m <sup>3</sup>          | ppm | ug/m <sup>3</sup>            | ppm | ug/m <sup>3</sup>         | ppm |
| Sulfur Dioxide (SO <sub>2</sub> )   | Annual              | 80                         | .03 |                              |     | 60                        | .02 |
|                                     | 24-hour             | 365                        | .14 |                              |     | 260                       | .10 |
|                                     | 3-hour              |                            |     | 1,300                        | .5  | 1,300                     | .5  |
| Total Suspended Particulates (TSP)  | Annual              |                            |     |                              |     |                           |     |
|                                     | (Geometric) 24-hour | 75                         |     | 60                           |     | 60                        |     |
|                                     |                     | 260                        |     | 150                          |     | 150                       |     |
| Nitrogen Dioxide (NO <sub>2</sub> ) | Annual              | 100                        | .05 | 100                          | .05 | 100                       | .05 |

\* Title 40 CFR Part 50, National Ambient Air Quality Standards. (Standards for averaging times of less than one year are not to be exceeded more than once a year.) The Environmental Protection Agency (EPA) set primary and secondary National Ambient Air Quality Standards (NAAQS) in April 1971. The primary standards were established to protect human health, whereas the secondary standards were established to protect the public welfare from any known or anticipated adverse effect.

\*\* Wyoming Ambient Air Quality Regulations, as amended in 1975. (Standards for averaging times of less than one year are not to be exceeded more than once a year.)



oxides, sulphur oxides, and hydrogen sulfide, are produced during disposal of liquid waste and unwanted gas, and by venting of noxious vapors from storage tanks. It is unlikely that air quality standard violations occur, or that impacts are noticeable outside the field.

Randolph Wood, Air Quality Division, Wyoming Department of Environmental Quality (personal communication, November 29, 1979), states that the number of permitted burns of petroleum waste and the number of accidental, unpermitted burns in any one year are approximately equal. Most burns occur in oil fields away from residential areas, and air pollution resulting from them is insignificant. The tendency now is to use biodegradable sludge from production facilities as fertilizer rather than burning it.

Accidental explosions, fires, and blowouts can occur, causing potentially serious air pollution problems.

Dust and exhaust emissions are produced by equipment during the rehabilitation of a dry hole or an abandoned oil well at the same rates as during construction.

Abandonment of an oil or gas well or a field ends the air contamination resulting directly from oil and gas activities, but continued use of the access roads by the public, surface owners, and (in some areas) uranium companies produces a small amount of dust for years.

The dust produced by the various oil and gas activities coats vegetation for up to .25 mile from the source. This may temporarily affect forage production and palatability (see vegetation section).

Dust either rises in a plume on windless days, or follows the land surface if there is any air movement. This causes a temporary visual impact because it degrades the usually unimpaired visibility in the area.

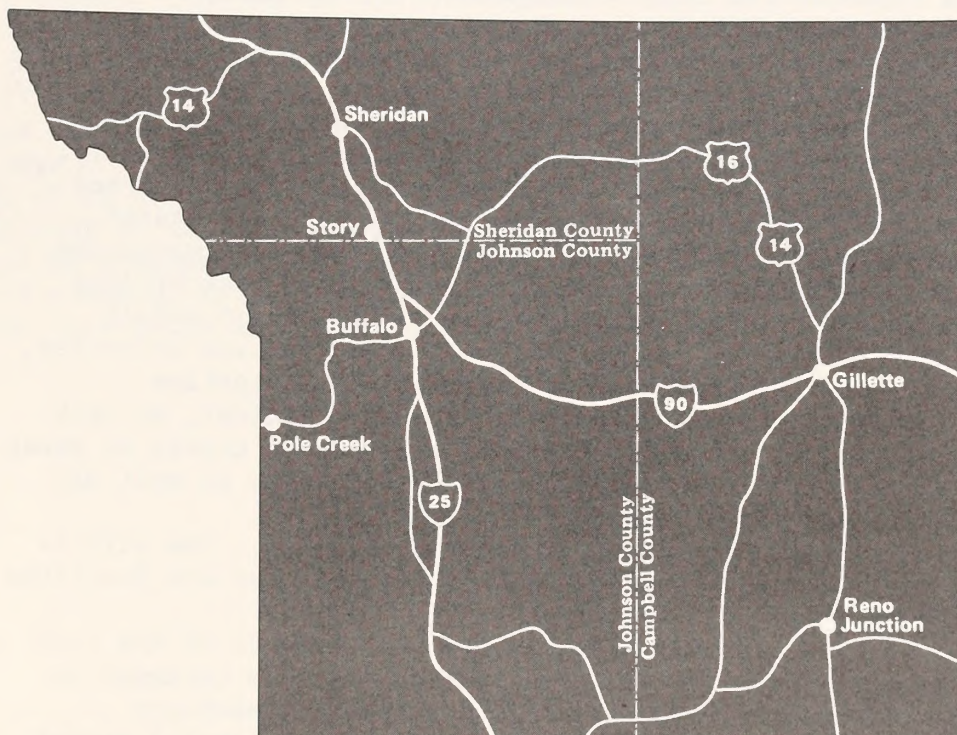


Figure 2 - 1  
Air Quality Monitoring Sites



## Topography

Although much of the Buffalo Resource Area is characterized by open, rolling plains, there are also areas of rough topography and steep slopes: the foothills and mountains on the west, the Powder River Breaks in northwest Campbell County, Pumpkin Buttes in southwest Campbell County, and the Rochelle Hills in eastern Campbell County. Steep slopes require special consideration in the management of the oil and gas program. This is because steepness of slope influences, in several ways, impacts on soils, vegetation, and water resources, as well as the chances for successful reclamation of surface disturbance.

In most cases, the Bureau of Land Management limits (BLM) surface disturbance for oil and gas activity to slopes less than 40%. This limitation is based on the field observations of BLM personnel, which are as follows. Areas with steeper slopes have fragile soils and vegetation, are impossible to reclaim, and are almost impossibly steep for the safe operation of earth-moving equipment. The construction of a drill pad or a road on slopes of 40% or more would require over 5 acres or nearly 9 acres per mile surface disturbance, respectively. Fill tumbled down the slope would be irretrievable. The disturbed area would be a sacrifice area, never successfully rehabilitated, continually eroding and contributing to soil loss and sedimentation. On steep slopes there is also an undetermined greater risk of land subsidence (slumps). Slumps would increase the amount of surface disturbance and the risk of oil spills, the latter if tank batteries, heater-treaters, or flowlines were upset or broken. Pipeline construction on steep slopes would probably be impractical, so tank trucks would be used to transport the oil. Year-round travel on steep roads would increase the risk of further surface damage, as well as vehicle accidents and human injury.

Problems with land subsidence are discussed below. The effects of slope and surface disturbance on soils and vegetation are described in the respective sections, following.

Disturbance of steep slopes aggravates the tendency of the land to slide or slump. There are numerous land subsidences (slumps) in areas of steep topography in northern Johnson County, southern Sheridan County, and northwestern Campbell County. A limited number of landslide problems are observed on Highway 16 as it dissects the face of the Big Horn Mountains along the west side of the resource area. Most of the slumps occur where the Fort Union and Wasatch formations are exposed and where slopes exceed 40% (see Map D, Appendix).

Whether or not a given portion of steep terrain slumps or gives way depends on its shearing resistance, which is the ability of the material to withstand pressure without sliding. A force applied to a mass of earth and rock is transmitted through the mass by contact pressure between individual particles. Pressure causes particles to rearrange and, while they are rearranging, they tend to slide with respect to each other. Sliding is reduced by frictional resistance.

Sliding commonly occurs along interfaces, such as sandstone-shale, soil-bedrock, fill areas-smooth in-place soil, etc. Depending on the degree and manner in which a steep slope is altered, its water content, and its permeability, some such layers may serve as slide surfaces.

Many factors contribute to the movement of rock and soil masses. Those most responsible are gravity, removal of support, expansion and contraction stresses, water saturation, and topographic slope changes.

From the list given above, the two most common causes of earth slippage resulting from oil and gas activities are removal of a portion of a slope (thus leaving the material above the removed portion with inadequate support) and/or an inadequate bond, which is easily penetrated by water, between the fill material and the in-place soil it covers. The factor which triggers slumps is probably penetration of the rock or soil by unusual amounts of moisture.

Slides, or slumps, have taken place on steep cut slopes of roads and well drilling locations. They have also taken place on the fill portions of well drilling locations and, to a lesser extent, along the outer edge of roads, when water penetrates the interface between the natural slope and the fill material.

Sliding or slumping affects the depth and stability of soil material on a slope: as the steepness of the slope increases, the rates of erosion, soil loss, and hence revegetation failure also increase (see soils and vegetation sections).





A slump at the outer edge of a location. Soil from this slump blocked a drainage at the foot of the slope. The cut portion of this location was on 25% to 30% slopes, and the fill portion on 40% + slope.

## Soils

Soil is unconsolidated material that has weathered from the underlying rock and/or has been transported by the action of wind, water, or ice and deposited on bedrock. The presence of some undecomposed organic matter and the weathering of minerals in the soil result in the formation of soil horizons. Usually, the uppermost layers of soil material, which are fertile and capable of supporting plant growth, are called topsoil. The soil material between the topsoil and the bedrock is known as subsoil.

Soils present in the Buffalo Resource Area vary in composition, depth, productivity (the ability to support plant growth), and physical characteristics. Those soils found in the mountainous areas are typically formed from limestone, sandstone, shale, and siltstone; thickness ranges from 8 to 40 inches; and organic matter content ranges from 2.5% to 14%. In contrast, soils found on the plains are typically formed from sandstone, siltstone, and shale; thickness ranges from nothing, where bedrock is exposed on steep slopes, to 60 inches or more in drainage bottoms; organic matter content is low, ranging from 1.5% to 4%.

Map E, Appendix, shows soil associations occurring in the resource area. The map was derived from Soil Conservation Service (SCS) generalized county soils maps. Soil associations are groupings of one or more major soils and at least one minor soil which occur in a distinctive pattern or proportion within the landscape. Soil associations are named for the dominant soils in each association. Associations shown on the map are grouped within six types of landscapes found in the resource area, and are described in detail in the Appendix.

Soils on approximately 1,200 acres are disturbed or damaged annually for oil and gas activity on federal mineral estate in the resource area (see Table 2-3). This represents a small proportion of the land in the resource area (.02%), but assumes significance because disturbed soils cannot be reclaimed as such. They may take many years to regain their original productivity (Final Environmental Statement on Eastern Powder River Basin Coal Resources (FES-79-17)). Furthermore, by 1990, oil and gas development on federal mineral estate will have disturbed 25,500 acres or 3.5% of the resource area. To put things in perspective, the construction of access roads and drilling locations for oil and gas wells in the resource area disturbs more acreage each year than all the operating coal mines in the three counties (FES 79-17).

There are five categories of impacts on soils resulting from oil and gas activities: compaction, mixing, burial, contamination, and removal.

Soil compaction results from use of vehicles, and the severity of compaction depends on the type of vehicle used, the soil texture, and the moisture content of the soil. Results of compaction are reduction in permeability and ability of roots to penetrate the soil.



Soil mixing commonly occurs when the surface is stripped or leveled for access roads or drill pads. If topsoil and subsoil or bedrock are mixed, which occurs especially where soils are shallow, the combination is often less productive than the original topsoil. Less productive soil supports sparse or poorer quality vegetation, which may, in turn, lead to erosion and soil loss.

Soil can be buried by water, road surface material, other soil material, or buildings and other facilities associated with oil and gas operations. The productive capacity of the buried soil may be destroyed or greatly reduced, depending upon the duration and depth of burial. The biological activity of the soil may be stopped or severely reduced with burial.

Soil contamination occurs when petroleum products, bentonite, drilling compounds, or poor quality water are spilled. Physical and chemical properties of the contaminants, such as high pH, high soluble salt levels, and the presence of trace elements, may adversely affect soil productivity.

Soil removal by machinery, wind, and water is the most significant impact caused by oil and gas activity. Removal of vegetation and topsoil during construction of access roads and drill pads exposes soils to erosion. The effects of wind and water may be compounded by other impacts to soils. A reduction in infiltration rate, resulting from compaction, or the loss of vegetation due to an oil spill, causes increased runoff and accelerated erosion.

The degree of impact on soils in each case of disturbance is influenced by topographic characteristics. Field observation by Bureau of Land Management (BLM) personnel has shown the following slope-related characteristics. On slopes up to 15%, reshaping the disturbed areas and redistributing the topsoil can be adequately accomplished. The reclamation of slopes from 15% to 30% is difficult. When roads or drill pads are constructed by conventional cut and fill methods on slopes of 15% to 30%, fill material is lost as it tumbles down the hillside and feathers out on the natural slope below. The soil often buries vegetation, reducing or eliminating its ability to grow and its ability to trap runoff. On slopes in excess of 30%, the excavated material drifts down the hillside to the bottom of the drainages, occasionally disturbing or uprooting trees. The material usually is not retrievable by conventional construction equipment.

An alternative to casting cut material over the edges of the hill is hauling it to a stockpile site and hence saving it for rehabilitation of the road or location. However, as the slope steepens, the mechanical ability to save and redistribute topsoil diminishes.

Soil erodibility varies by soil type and degree of past erosion, when factors such as climate, soil cover, and erosion prevention practices remain the same. Some of the soil properties that influence soil erodibility are soil texture; percentage of coarse fragments, especially on the surface; size and stability of soil structure; type of clay content; soil permeability and infiltration; organic matter content; and depth of soil material. The rate at which a particular



soil type will erode has been computed by the SCS through the use of a soil erodibility nomograph using five soil parameters. The five parameters are percent silt plus very fine sand, percent sand (0.10-2.0 mm), organic matter content, structure, and permeability.

Then the Universal Soil Loss Equation, developed by the SCS, can be used to determine ranges in the amount of soil loss expected from water erosion. Table 2-7 shows estimates of expected soil losses in tons per acre for the majority of the soils identified on Map E, Appendix. The soil losses were figured on a 300-foot slope length at 10%, a 300-foot slope length at 20%, and a 400-foot slope length at 30%. These slope lengths correspond to the surface disturbance that would result when oil drill pads or roads are constructed on these slopes on these soil types. The soil losses in Table 2-7 were calculated for bare soil with no vegetative cover to illustrate the expected soil loss on a newly reshaped, abandoned well drill site. Soil loss can be expected to be greater on longer slopes and less on shorter slopes. On long slope lengths, when rainfall exceeds soil infiltration rates and the capacity of water surface retention devices, concentrations of runoff result.

The Soil Conservation Service and the Agricultural Research Service State Experiment Station, both involved in erosion research, have established soil loss tolerance values for most of the soils found within the Buffalo Resource Area. Soil loss tolerance is the maximum amount of soil loss, in tons per acre per year, that can be tolerated and still achieve a degree of conservation needed for sustained economic production. (BLM uses the SCS soil loss tolerance values as a guide for determining the impacts of soil erosion.)

Soils in the resource area have a loss tolerance varying from 1 to 5 tons per acre per year. Observations and experience indicate that a 5-ton average annual soil loss should be the maximum for any soil. Generally, a 5-ton limit is assigned to the deeper, more permeable, well-drained soils, and the 1- or 2-ton tolerance is assigned to thin, poorly drained soils. Table 2-7 shows the soil loss tolerance in tons per acre for the soils identified on Map E, Appendix.

The degree of impact on soils resulting from surface disturbance can be reduced by proper construction and rehabilitation practices. Specifications for construction and rehabilitation of access roads and drill pads are included in Surface Operating Standards for Oil and Gas Exploration and Development, a booklet published by the Geological Survey, the Bureau of Land Management, and the Forest Service. The purpose of the specifications is to prevent damage to the soils and, in turn, to vegetation, wildlife, and land uses such as ranching.

Unfortunately, such recommendations are not always followed. Problems presently occurring in the resource area as a result of poor road and drill pad construction practices, the timing of construction, or poor rehabilitation are as follows.

The presence of excessively long grades without provision of adequate relief culverts and water retention devices concentrates runoff and increases its flow velocity.



TABLE 2-7

ANNUAL SOIL LOSS AND ANNUAL SOIL LOSS TOLERANCE  
(Tons per acre)

| Soil Type    | Soil Loss |           |           | Soil Loss<br>Tolerance |
|--------------|-----------|-----------|-----------|------------------------|
|              | 10% Slope | 20% Slope | 30% Slope |                        |
| Absted       | 10        | --        | --        | 4                      |
| Ascalon      | 5         | --        | --        | 5                      |
| Bankard      | 3         | --        | --        | 5                      |
| Barnum       | 12        | --        | --        | 5                      |
| Bidman       | 9         | --        | --        | 5                      |
| Big Horn     | 12        | --        | --        | 5                      |
| Bowbac       | 3         | 23        | 52        | 3                      |
| Briggsdale   | 9         | 26        | --        | 5                      |
| Burgess      | 6         | 15        | --        | 5                      |
| Cragola      | 6         | 19        | 43        | 1                      |
| Cushman      | 9         | 26        | 60        | 3                      |
| Decross      | 9         | 26        | --        | 5                      |
| Fort Collins | 6         | 19        | --        | 5                      |
| Gateson      | 10        | 30        | 68        | 2                      |
| Gaynor       | 12        | 35        | --        | 3                      |
| Glenberg     | 6         | 15        | --        | 5                      |
| Haverson     | 9         | 26        | --        | 5                      |
| Hazton       | 5         | 14        | 32        | 1                      |
| Kim          | 10        | 30        | --        | 5                      |
| Kirtley      | 12        | 35        | 80        | 3                      |
| Lohnmiller   | 12        | --        | --        | 5                      |
| Mathers      | 9         | 26        | 60        | 5                      |
| Maysdorf     | 6         | 15        | --        | 5                      |
| Moret        | 10        | 30        | 68        | 1                      |
| Olney        | 6         | 15        | 33        | 5                      |
| Passcreek    | 10        | 30        | --        | 2                      |
| Pugsley      | 6         | 19        | --        | 3                      |
| Redbanks     | 12        | --        | --        | 5                      |
| Renohill     | 12        | 35        | --        | 3                      |
| Samsil       | 12        | 35        | 80        | 2                      |
| Schooner     | 5         | 16        | 36        | 1                      |
| Shingle      | 10        | 30        | 68        | 2                      |
| Spearfish    | 12        | 35        | 80        | 3                      |
| Stoneham     | 6         | 19        | 43        | 5                      |
| Sunup        | 10        | 30        | 68        | 1                      |
| Tassel       | 3         | 23        | 52        | 1                      |
| Terry        | 6         | 19        | --        | 3                      |
| Thedalund    | 10        | 30        | 68        | 2                      |
| Ulm          | 10        | --        | --        | 5                      |
| Wibaux       | 9         | 26        | 60        | 1                      |
| Wolf         | 10        | 30        | 68        | 3                      |
| Woosley      | 9         | 26        | --        | 2                      |
| Wyarno       | 12        | 35        | --        | 5                      |

Disturbance of unstable slopes or areas having a high groundwater table may result in landslides and revegetation problems.

Failure to maintain adequate distances between the fill slopes on roads and drainages will not permit the retrieval of the soil during rehabilitation activities.

Rutting and saturation of roads results from (1) the failure to construct them in a manner that would permit surface drainage and prevent water's being absorbed into the road, or (2) designing roads for dry weather and using them year-round.

Construction of roads from frozen soil and snow results in settling and forming of underground voids when warm temperatures thaw the material. This may cause a safety hazard and also allow the surface runoff to penetrate and saturate the road bed.

Failure to properly stabilize ditches with structures and/or vegetation makes the channel susceptible to erosion and also provides for increased flow velocity.

Failure to properly install culverts or other structures to carry the flow across the roadway can result in gully erosion within the ditch and/or ponding of the runoff in the ditch, which can result in saturation of the roadway.

Disposal of concentrated flow, such as runoff discharged from culverts, can cause severe gullying if stabilization and energy dissipation measures are not used.

Inadequate maintenance of existing fields or rehabilitation of abandoned roads and locations increases the rates of erosion and soil loss.





The fill slope at this location is eroding.



Access road constructed without provision for surface drainage. Drivers detour around ruts and ponds which form in wet weather.



## Water Resources

### Surface Water

The principal drainages of the resource area are the Powder (which drains over 65% of the area), Little Powder (3%), Belle Fourche (11%), Cheyenne (6%), and Tongue (14%) river systems. All of these rivers are tributaries of the Missouri River system, and have, in turn, many perennial (flowing year-round) streams draining into them. A greater number of the perennial streams are found, and have their beginnings within the Big Horn Mountains to the west, with lesser numbers in the eastern portion of the resource area.

The perennial streams have many ephemeral (flowing only in response to rain or snowmelt) streams within their drainage systems.

Precipitation in the resource area falls mostly as snow or rain during spring or early summer. Forty-four percent of the moisture falls during the months of April, May, and June. Winter is usually the driest season of the year, with only 13% of the total precipitation occurring then. Heavy rainfall occurs during brief summer thunderstorms. The average annual precipitation varies within the resource area. The highest amount of precipitation, 22 to 26 inches, falls on the Big Horn Mountains, while the lowest, 10 to 12 inches, falls in southern Johnson and Campbell counties. Around 16 inches falls annually around the city of Sheridan, while Gillette in Campbell County receives around 12 to 14 inches annually.

Mean monthly flow volumes of streams in the region reflect the precipitation pattern: the highest flows occur from March through June and the lowest during October, November, and December (see Table 2-8).

Quality. The two principal parameters affecting surface water quality in the resource area are sediment and total dissolved solids. Rates of erosion, and hence sedimentation, depend upon precipitation, the rate of water flow, the erodibility of the soil, and the protective influence of vegetative cover. Total dissolved solid (predominantly salts) concentrations depend on the mineralogy of the rocks and vary inversely with the water flow. Concentrations of sediment and salts in waters of the Tongue River drainage are the lowest in the resource area. In Goose Creek near Sheridan from October 1977 to September 1978, suspended sediment ranged from 9 milligrams per liter (mg/l) to 1,660 mg/l and total dissolved solids from 100 mg/l to 519 mg/l (U.S. Department of Interior, Geological Survey 1980). The Tongue River drainage is the most humid, and thus tends to have more vegetative cover and less erosion than other areas. Also, the higher precipitation in the area has possibly leached much of the natural salts from the soils and bedrock.

Other surface waters within the resource area are high in sediment and total dissolved solids. For example, measurements in the Powder River at Arvada from October 1977 to September 1978 were as follows: suspended sediment ranged from 1,720 mg/l to 51,000 mg/l and total dissolved solids from 653 mg/l to 2,280 mg/l (ibid.).



TABLE 2-8

MEAN MONTHLY STREAMFLOWS  
(Thousands of Acre-Feet)

|                                                                                                   | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---------------------------------------------------------------------------------------------------|------|------|------|------|-----|------|------|------|------|------|------|------|
| Powder River at Arvada, WY<br>(T. 54 N., R. 77 W.)                                                | 6    | 11   | 21   | 22   | 42  | 54   | 16   | 5    | 6    | 7    | 9    | 6    |
| Tongue River at Wyoming/<br>Montana state line                                                    | 14   | 16   | 25   | 26   | 75  | 115  | 31   | 10   | 26   | 18   | 15   | 11   |
| Belle Fourche River near<br>Moorcroft, WY, 10 miles<br>east of the Campbell/<br>Crook county line | .1   | .5   | 3    | 1    | 2.8 | 4.8  | 1    | .3   | .2   | .1   | .1   | .1   |
| Little Powder River near<br>Broadus, MT, 30 miles<br>north of the Wyoming/<br>Montana state line  | .5   | 2.5  | 10   | 3.5  | 3   | 4.7  | 1.8  | .8   | .5   | .5   | .5   | .5   |

Source: Surface water data, reports of Geological Survey.

This situation stems from several facts. (1) Most of northeastern Wyoming is semiarid; this contributes to the sparse vegetative cover and hence soil erosion rates. (2) Precipitation is concentrated in short periods, either in summer thunderstorms or coinciding with spring snowmelt; sediment-carrying capacity and erosive power of streams during these periods is great. (3) Much of the soil has low infiltration and slow permeability rates, so that water runoff is rapid. (4) The soil contains high levels of soluble salts (caused by high evapotranspiration rates, poor leaching due to slow permeability, and exposed saline and alkaline shales); these high salt concentrations are detrimental to vegetative growth; they also affect water quality as the soil erodes. (See the Final Environmental Statement on Eastern Powder River Basin Coal Resources (FES 79-17) for further information on water quality.)

Impacts. Any activity which increases soil erosion rates, including the surface disturbance associated with oil and gas development, can affect surface water quality. However, the rate of soil erosion is not directly related to sediment yield; the latter is determined by particle size, distance to water, and severity of storm. Most sediment generated does not immediately reach live water (perennial streams), but is deposited in ephemeral drainages where it may remain until an unusually heavy rainfall event.

Oil and gas activity is not believed to be a major contributor of sediment in perennial streams in the resource area (Wyoming State Engineer 1972 and Bureau of Land Management (BLM) field observation). This is partly due to location and construction stipulations placed on surface-disturbing activities near perennial streams and partly to the fact that most streams are heavily laden with sediment from natural erosion.

The most significant impact from increased sediment would be site specific and would involve stockponds and reservoirs in ephemeral drainages directly downstream from areas disturbed. The life expectancy of these watering facilities could be shortened from increased sediment. The impact from sedimentation would be greatest from established oil fields where there is a concentration of surface disturbance from various activities. The highest amounts of sediment loads can be expected during summer months from severe storms. Lesser amounts of sediment are generated from spring snowmelt.

The chemical quality of surface water can be adversely affected if oil or fluids containing toxic materials are spilled. There were 20 reported oil spills in the resource area in 1979: 16 in Campbell County (3,240 42-gallon barrels); 4 in Johnson County (123 barrels); and none in Sheridan County. This is an increase of 1 spill over 1978 (personal communication, Leroy Feusner, Wyoming Department of Environmental Quality, April 25, 1980). Precise spill records do not exist for earlier years. Most oil spills are caused by pipeline leaks or ruptures (ibid.), and rarely does oil from a spill enter live water. However, if clean-up is inadequate (see vegetation section, following) oil remaining on vegetation, rocks, and soil will be picked



up by runoff and carried into ephemeral drainages, stockponds, or eventually live water.

Drilling or production fluids in the reserve pit may contain toxic chemicals, as well as brackish water and oil. In the Buffalo Resource Area, drilling is done with fresh water and additives, such as bentonite and calcium chloride. Once the desired oil-bearing formation is reached, hydrochloric acid along with a corrosion inhibitor, consisting mainly of chromates, is pumped into the formation. The acid is used to remove the bentonite that has coated the oil producing sands. Once the bentonite is removed, 100 to 500 gallons of acid are pumped back out of the formation into the reserve pit. A fracturing gel may then be used to improve the flow of oil. The gel eventually reverts to a liquid after use and is pumped out of the oil-bearing formation into the reserve pit. The chemical compounds and concentrations used in the gel vary from company to company. However, some of the chemicals used are bicarbonate of soda, sodium hydroxide, and small amounts of phosphates. Guar gum from the guar tree may sometimes be used to make the mud slick or slippery.

Any chemical, in sufficient concentration, can be considered toxic. If a reserve pit ruptures, leaks, or overflows, the fluid can eventually contaminate live water, in addition to killing vegetation and contaminating the soil. BLM field personnel estimate that three pits in one hundred break or leak, and that the spilled fluid rarely reaches stockponds or streams. Most cases of pit rupture occur because the reserve pit was constructed with inadequately compacted walls or in a drainage.

Because any water discharged from an oil and gas operation must be permitted by and meet the standards of the Wyoming Department of Environmental Quality (DEQ) (see Table 2-9), the adverse impact of such authorized discharges on surface water is considered nonexistent. In fact, such discharges may be beneficial to wildlife and livestock (see respective sections). The number of permitted discharges from oil production facilities within the resource area is constantly changing as new wells are drilled and existing discharges are eliminated. The number of permits was 48 in 1978 (personal communication, John Wagner, DEQ, May 9, 1978). The discharge of production water is usually localized, with a number of discharge sites within a few miles of each other. For instance, the majority of the permitted sites in Johnson County are within the Salt Creek and Meadow Creek oil fields in the southeastern portion of the county. Water permitted for discharge in the resource area flows into the Powder, Little Powder, or Belle Fourche drainages.

There is probably some unpermitted discharge of water within the resource area, but the amount is not known (*ibid.*). Such discharge may have a minor adverse impact upon surface water quality.

All perennial streams and major ephemeral streams, as shown on Map B, Appendix, are within identified floodplain hazard areas. Wetland areas are found along the perennial and major ephemeral streams. The width of floodplains, especially along ephemeral streams, varies considerably, depending on topographic contour



TABLE 2-9  
EFFLUENT LIMITATIONS FOR PRODUCED WATER IN WYOMING

Produced water is defined as underground water which surfaces through oil and/or gas wells and which is usually disposed of by reinjection, discharge to complete containment ponds, or, after treatment for removal of oil, discharged to surface waters of the state.

-- Chlorides - The chloride content of any produced water discharge shall not exceed 2,000 mg/l in any single properly preserved grab sample except in those cases where a modification is granted for beneficial use or in extenuating circumstances.

-- Sulfates - The sulfate content of any produced water discharge shall not exceed 3,000 mg/l in any single properly preserved grab sample except in those cases where a modification is granted for beneficial use or in extenuating circumstances.

-- Total Dissolved Solids - The total dissolved solids content of any produced water discharge shall not exceed 5,000 mg/l in any single properly preserved grab sample except in those cases where a modification is granted for beneficial use or in extenuating circumstances.

-- pH - In no case shall the pH of any produced water discharge be less than 6.5 or greater than 8.5 as measured by a single grab sample.

-- Oil and Grease - In no case shall the oil and grease content of any produced water discharge exceed 10 mg/l in any single properly preserved grab sample.

-- Toxic Substances - In no case shall any produced water discharge contain toxic substances in concentrations or combinations which are toxic to human, animal or aquatic life.

-- Additional Limitations - The state reserves the right to impose limitations on additional parameters or to impose limitations more stringent than those given above to protect water quality.

Source: Wyoming Water Quality Rules and Regulations, Chapter VII.



intervals and the size of the areas being drained by the stream. Floodplains narrow in width as the topography becomes steeper.

Occasionally wells are drilled in wetlands, on floodplains, or where contamination of live water by a ruptured reserve pit would be inevitable. In these cases special construction methods are stipulated so that adverse impacts can be prevented. The possibility of an oil or chemical spill exists; the severity of the impacts would depend on the size of the spill, its proximity to downstream users, and the effectiveness of clean-up.

Because of requirements for surface casing and prohibitions on surface disturbance near perennial streams, oil wells would not be expected to have any adverse impact on the hydrologic function of alluvial valley floors.

### Groundwater

Aquifers (water-bearing formations) important for water supplies in the resource area are the alluvium and the Wasatch and Fort Union formations (see Figure 1-4).

The alluvium is unconsolidated silt, sand, and gravel, usually less than 50 feet thick, which occurs in the valleys of perennial streams. Dissolved solids in water from alluvium commonly range from 500 to 1,500 mg/l (FES 79-17). (Environmental Protection Agency and State of Wyoming recommendations for human and stock consumption are 250 mg/l and 5,000 mg/l, respectively, while the limit for irrigation is 1,500 mg/l (Powder River Areawide Planning Organization 1977).) Well yields range from a few to more than 1,000 gallons per minute (gpm).

The Wasatch Formation is composed of layers of sandstone, shale, and coal. Its greatest thickness is about 1,600 feet along the central axis of the Powder River Basin (see Figure 2-2). Dissolved solids in water from the Wasatch commonly range from 500 to 1,500 mg/l, and well yields vary from 10 gpm in the northern part of the basin to 500 gpm in the southern part.

The Fort Union Formation is also composed of sandstone, shale and coal layers. It underlies the Wasatch in the central part of the basin, but is exposed on the edges of the basin. The Fort Union Formation is up to 3,400 feet thick. Water from the Fort Union commonly contains 500 to 1,500 mg/l dissolved solids, and maximum well yields are about 150 gpm.

Most of the groundwater from wells in the resource area is used for domestic and stock supplies and is obtained from drilled wells and from springs. In some areas, drilled wells are the only source of water for livestock, but in other areas wells supplement surface supplies. The quality of groundwater where most of the oil and gas activity occurs is generally considered fair to poor for domestic use and good to poor for livestock.

Impacts. All three aquifers are drilled through to reach oil and gas. Possible impacts to groundwater from oil and gas operations are

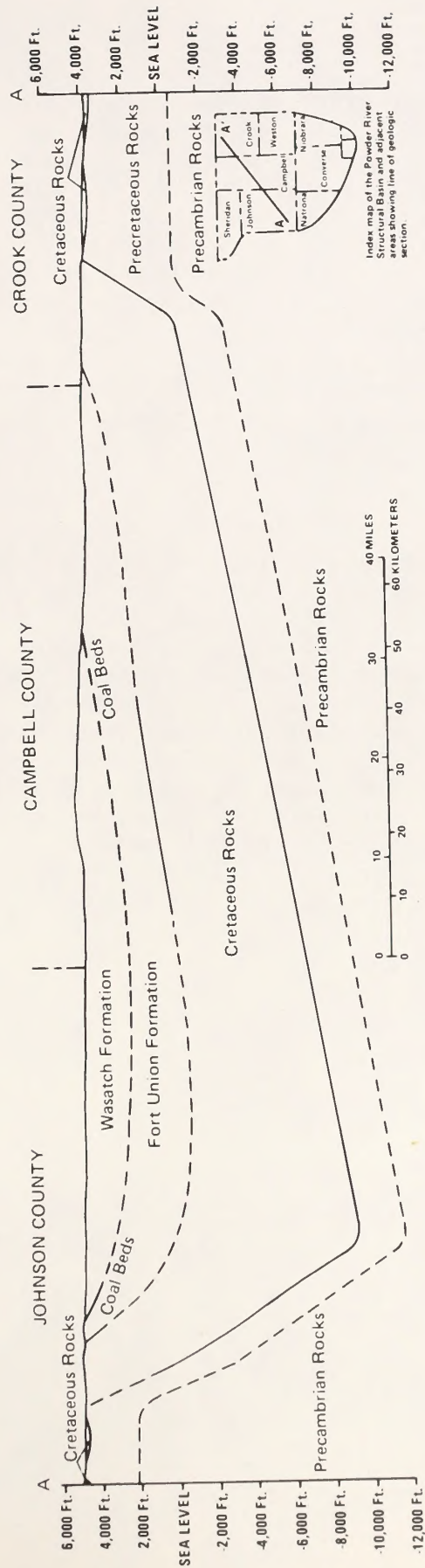


Figure 2 - 2  
Generalized Geologic Section of the Powder River Basin  
and Adjacent Areas, Northeastern Wyoming



the mixing of water from different aquifers and the leakage of toxic materials into shallow aquifers during drilling operations. Regulations require that drill hole casing be cemented in place to a depth of at least 150 feet, or more if necessary to prevent mingling of aquifers and contamination by toxic materials. Failures, or leaks, occur in .5% to 1% of the wells drilled (personal communication, Glen Worden, Geological Survey, August 1979). Usually the amount of drilling fluid or brackish water that then infiltrates the aquifer(s) is small and greatly diluted by mixing in the aquifer; therefore, no significant impact ordinarily occurs.

It is possible that well water use for drilling or secondary recovery could lower water levels in nearby domestic wells. If a problem develops, it would be resolved by the State Engineer based on the precedence of water rights.

#### Water Use for the Oil and Gas Industry

The water needed for drilling operations is usually obtained from streams, privately owned stock reservoirs, or existing wells. In some cases, shallow water wells are drilled for the needed water. Because water use permits are required by Wyoming law and are issued by the State Engineer's Office, existing water appropriations are protected. The amount of water needed by the oil and gas industry annually in the three-county area is expected to remain constant (see Table 2-4) and have little effect on total supply. It is anticipated that water used by the oil and gas industry will become a smaller proportion of total use in the resource area, due to industrial development, particularly coal-related, and population growth (see FES 79-17).

## Vegetation

The vegetation of the Buffalo Resource Area ranges from sparse saltbush and grass on shale soils of the plains to heavily timbered areas of the Big Horn Mountains. Intermixed sagebrush/grassland predominates in the resource area. On the ridges and rougher areas of the plains, the mixture of sagebrush and grassland is broken by timber (juniper and pine) in patches of varying density and extent.

Vegetative communities vary depending upon soil types, precipitation, elevation, and temperatures. The resource area can be divided into four precipitation/vegetation zones (see Map F, Appendix). These four zones correlate generally with elevation and precipitation. The changes in elevation and precipitation are gradual; therefore, transition zones can be extensive in some areas. A brief description of each zone is given below. A list of key climax plant species that occur in each zone appears in the Appendix. The concept of precipitation/vegetation zones is used by the Bureau of Land Management (BLM) primarily for establishing seeding mixtures to be used in rehabilitation of disturbed areas (see Map N, Appendix).

10-14" Northern Plains Precipitation/Vegetation Zone. The annual precipitation varies from 10 to 14 inches. Available moisture is at its lowest during December, January, and February, increasing rapidly until the last half of May and first part of June. Precipitation then decreases to a low in August, increases toward a secondary high in September and then decreases to its wintertime low. The elevation ranges from 3,800 feet to 5,100 feet. Temperatures show a wide range between summer and winter and between daily highs and lows. Characteristic vegetation types are sagebrush, grass, and riparian (streambank) species.

15-17" Northern Plains Precipitation/Vegetation Zone. Annual precipitation varies between 15 and 17 inches. Precipitation shows its lowest amount during February, increasing until mid-June, decreasing rapidly to an August low, and increasing to a secondary peak in mid-September. The amount then decreases until February. Elevation ranges from 3,400 feet to 4,600 feet. This zone is located within the path of cold air outbreaks from Canada. Thus, temperatures show a wide range between summer and winter and between daily highs and lows. Late spring and early fall freezes are common. Cool season plants begin growth about April 1, continuing until July 1. Warm season plants begin growth about mid-May, continuing until mid-August. A fall green-up may occur in September and October. Characteristic vegetation types are sagebrush, grass, conifers, and riparian species.

15-19" Northern Plains Precipitation/Vegetation Zone. Annual precipitation varies from 15 to 19 inches. The greatest amount of moisture occurs in June. Average snowfall is 150 inches. The elevation ranges between 3,700 and 7,500 feet. Temperatures show a wide range between summer and winter and between daily highs and lows. Temperatures during summer months range from the 70s to mid-90s during the daytime to the 30s at night. Winters are cold, with temperatures below freezing most of the time. During the coldest months,



temperatures can range from 20°F during the daytime down to -40°F at night. Cool season plants generally start growth the first of May, continuing until mid-October. Characteristic vegetation types are sagebrush, grass, conifers, and mountain shrubs.

20"+ High Mountains Precipitation/Vegetation Zone. The average annual precipitation exceeds 20 inches, distributed somewhat evenly throughout the year. Annual snowfall averages 150 to 200 inches. Summer precipitation is in the form of showers. Spring and fall, however, produce both showers and steady precipitation. The elevation ranges from 8,200 to over 12,000 feet. The temperatures show a wide range between summer and winter and between daily highs and lows. The average monthly temperatures vary between 12°F and 60°F, averaging about 37°F for the year. Characteristic vegetation types are grasses, conifers, and mountain shrubs.

Each precipitation/vegetation zone is characterized by several vegetative types, as noted above. These types are shown on Map F, Appendix, and percentage figures for the major types are shown in Table 2-10. Vegetative type groups are used by BLM to determine impacts of surface disturbance, because they are easily identified on the ground and easily related to soils and wildlife habitat.

Most oil and gas activity in the resource area occurs within the sagebrush or grass vegetative type (see Maps A and F, Appendix).

#### Impacts on Terrestrial Plants

Geophysical Exploration. Geophysical exploration has a minimal impact on the vegetal resource. Off-road seismograph activity may cause soil compaction, accelerated erosion and siltation, and mechanical injury to plants. The duration of such activities is usually temporary and the magnitude of disturbance is negligible, depending on the time of year such exploratory activities take place. However, vehicle travel along a seismograph line often establishes a well-defined two-track trail. Such trails may be interpreted by hunters as roads, and in fragile soil conditions permanent soil and vegetation damage can occur. When dirtwork is conducted, there is a direct loss of vegetation. However, stringent rehabilitation requirements are stipulated and these areas are brought back into production within 2 or 3 years. Seismic exploration may disturb an average of .10 acre per mile. Under the probable level of development, seismic exploration in the Buffalo Resource Area would disturb an average of 800 acres per year (Table 2-3).

Access Roads and Well Locations. A large portion of the damage to vegetation incurred from oil and gas activity is directly related to the development of access roads and drill sites. The most significant impact is the direct loss of vegetation due to surface disturbance. The construction of a drilling/production location destroys vegetation on an average of 4.1 acres, depending on the degree of slope. An average of 4.8 acres of vegetation per mile is destroyed due to access roads (Table 2-2).

Dust on vegetation, resulting from heavily used access roads, is arecognized problem, but is difficult to measure. Dust on green vegetation could possibly affect palatability, resulting

TABLE 2-10

## VEGETATIVE TYPES AS A PERCENTAGE OF TOTAL LAND AREA

| <u>Vegetative Type</u> | <u>Campbell</u> | <u>Johnson</u> | <u>Sheridan</u> |
|------------------------|-----------------|----------------|-----------------|
| Grass                  | 42%             | 50%            | 16%             |
| Sagebrush              | 45%             | 33%            | 20%             |
| Saltbush               | .06%            | .2%            | --              |
| Greasewood             | .2%             | --             | --              |
| Mountain shrub         | --              | .6%            | --              |
| Conifer/dense timber   | 3%              | 6%             | .7%             |
| Broadleaf tree         | --              | .4%            | .5%             |
| Meadow                 | --              | .04%           | --              |
| Cropland               | 10%             | 6%             | 2%              |
| Other                  | --              | 3%             | 61%*            |

Source: Bureau of Land Management, Unit Resource Analysis, Buffalo Resource Area, 1976.

\* Includes large areas unsurveyed by the Missouri River Basin vegetation survey.



in a loss of usable livestock forage for up to .25 mile from access roads. Since rains periodically wash dust from the vegetation, such an impact is only temporary.

Accidental oil and saltwater spills also affect the vegetation. When spills occur, the surrounding vegetation may be killed, reducing livestock forage and creating erosion problems.

The major factors determining the impact of oil spills on the ground surface are the extent of the spill, length of time the oil has been on the ground surface, and the physical properties of the oil involved. Oil spills on the ground surface are dealt with in two different ways. The oil can either be burned off or be physically removed. Although these techniques are not completely effective, they do greatly mitigate the potentially serious impacts. The physical properties of the oil can determine the effectiveness of corrective measures. Light oils burn off more easily (with a hotter flame) than the heavier asphaltic oils but tend to seep into the soils more readily. If these types of oils are allowed to seep into the ground surface, soil sterilization is possible for long periods of time, subjecting the ground surface to severe erosion problems. Heavy oils are difficult to burn off effectively and, in cold weather situations, can be physically removed (shovelled up) more easily. Surface oil residues are never removed completely. Even when light oils are burned off as completely and effectively as possible, a slight discoloration is visible on the ground surface, and vegetative recovery is slightly affected. Vegetation is more seriously affected when congealed oil is still visible on the soil or vegetation surface.

Because they are more visible, oil spills can be corrected more readily and effectively than saltwater spills. Saltwater changes the chemistry and fertility of the soil; it can change the vegetative type to salt grasses, or kill all vegetation.

Discharge water from oil treaters may be high in mineral content or chemical contaminants. If such discharge waters are allowed to run on the ground surface, the soil and vegetation may be adversely affected.

Access roads and drill sites can also have a beneficial impact on the surrounding vegetation. Such disturbed surfaces can direct surface runoff toward adjacent vegetation, increasing forage production. Produced water can be discharged on the surface, if it meets quality standards, and thereby provide additional moisture for plant growth.

Abandonment. Upon abandonment, surface rehabilitation programs must be developed to insure vegetative recovery and to return the disturbed area to its original condition or one compatible with the existing environment. If left unrehabilitated, it can take as much as 10 years or more for a disturbed site to naturally revegetate itself. This results in delayed vegetative recovery, leaving the exposed surface vulnerable to erosion and invasion of noxious weeds. If reseeded, 2 to 3 years may be required for complete vegetation establishment.



Factors preventing successful revegetation are steep slopes, drought conditions, poor soil properties, loss of seed due to sudden downpours, and destruction of seedlings by wildlife and livestock.

The success of vegetative recovery also depends on the techniques utilized in rehabilitation. A description of the revegetation techniques recommended or required by the Bureau of Land Management is given in Chapter 1.

The long-term impact of rehabilitation on vegetation is loss of species diversity. Newly established stands of grass contain only four or five species compared with the tens of species of grass and forbs found on a plot of native range. The lack of diversity means that the stand is less resistant to disease, insects, changes in weather, and the impacts of grazing. The change in diversity is magnified if the vegetative type originally disturbed was shrub (including sagebrush) or timber. The reestablishment of such communities is usually dependent on natural succession, which may take 30 years or more (University of Wyoming 1976).

Rights-of-way. The development of pipelines and power distribution systems results in a loss of vegetation due to surface disturbance, but such areas are reseeded and usually back in production within 2 to 3 years. An average of 24 acres per mile (see Table 2-2) is disturbed with the construction of underground pipelines, while transmission line installation destroys only a small amount of vegetation. Service maintenance roads along pipelines and power lines may destroy more vegetation than construction, especially if the roads are used frequently.

#### Impacts on Aquatic Plants

Aquatic plant growth and development depends on several physical and chemical attributes. Light, water, temperature, bottom type, and dissolved gases and nutrients are all requirements that are interrelated, each of which can be a limiting factor (Department of Natural Resources 1974). Oil and gas exploration or development can degrade the aquatic environment, if any one of these required attributes is adversely impacted, creating a limiting condition.

Surface disturbances, such as the construction of roads, pipelines, and other facilities, can accelerate erosion and sedimentation. Sedimentation can increase turbidity levels, reducing available light and aquatic plant production. Increased sediment loads can also destroy certain individual plants by suffocation or abrasion. Increased sedimentation in drainages and stream channels can result in rooted aquatic plants becoming more prevalent. Such increases in production of plants can lead to choked stream channels.

Desiccation of an aquatic environment can possibly occur if shallow aquifers are not cased and are drained during drilling operations. Partial or complete destruction of boggy areas can result from drill pad and road construction.

Discharge of treater waters can have variable effects on the aquatic community, depending on the water quality. Increased moisture in drainages can accelerate aquatic plant establishment, changing the





A properly reshaped and revegetated abandoned location. This location was fenced until vegetation was established.

existing vegetative composition. Discharge waters usually leave treaters at high temperatures. Algae and moss production can increase as a result of such water entering standing water bodies.

Poor quality discharge water or oil spills which reach live water can kill existing aquatic plants. These direct toxic effects can also occur as a result of mud pit washouts or runoff from drill sites.

#### Threatened or Endangered Species

There are no plants in the resource area currently listed or proposed for listing as threatened or endangered. (Sullivantia hapemanii and Eriogonum lagopus are no longer being considered for formal listing.)

If threatened or endangered species are identified in the future, stipulations for their protection would be attached by the Bureau of Land Management to leases issued or surface-disturbing activities approved in areas where they grow. If a listed species or its habitat might be affected by oil or gas activities, consultation with the U.S. Fish and Wildlife Service is required (see Appendix, Laws and Enforcing Agencies).



## Wildlife

### Terrestrial Habitat

The construction of drill pads, roads, pumping stations, and communication sites removes all cover for wildlife. This cover is lost for the lifespan of the development. By 1990, 25,500 acres in the resource area will have been disturbed by oil and gas activities. Although reclamation will have been completed by 1990 on 10,245 acres, or 40% of the land disturbed, none of the reclaimed areas will be suitable habitat for wildlife requiring shrubs or trees for food and cover. Replacement of wildlife habitat will take many years. For example, in areas where sagebrush is a major component of the vegetation, the loss of brushy cover will last for 30 or more years after site rehabilitation is completed (University of Wyoming 1976). Loss of habitat is expected to occur primarily in the sagebrush or grass vegetative type. If that expectation is borne out, the loss represents approximately .5% of those habitat types in the resource area.

Loss of habitat means a corresponding loss in carrying capacity (the ability of the land to support wildlife). Using wildlife species characteristic of the sagebrush and grassland habitat, loss of habitat on 25,500 acres means that the carrying capacity of the resource area would be reduced by approximately 180 pronghorn, 120 mule deer, and literally thousands of small mammals, birds, reptiles, and amphibians. (Wildlife densities, on which these numbers are based, are given in the Final Environmental Statement on Eastern Powder River Basin Coal Resources (FES 79-17).)

In addition, traffic, noise, and human activity on disturbed areas lowers the carrying capacity of adjacent, undisturbed land. The amount of disturbance to a particular species depends on the species' tolerance to disturbance and the type and duration of the disturbance. Elk, for example, are acutely sensitive to human disturbance, and oil and gas activity in elk habitat creates a more significant impact than similar activity in pronghorn habitat (see below). These impacts are not quantifiable.

One of the effects of oil and gas exploration and development which is hardest to measure is the cumulative effect this development has, along with the development of coal, uranium, the associated rights-of-way, and increased acreage required for residential and municipal areas.

Coal development in Campbell County is currently restricted to a narrow strip a few miles wide from the southern Campbell County line to north of Gillette. There are numerous oil fields in this same vicinity, which increases the number of people, roads, vegetative disturbance, and noise. Added to this are the new Gillette-Orin railroad line, new roads to coal mines, new petroleum pipelines, and new power lines. Each of these factors separately does not cause such a large amount of disturbance that resident and migratory wildlife are unable to adapt. However, together, all of these various kinds of development have a significant, negative impact on wildlife habitat



through direct destruction of habitat and loss of carrying capacity on adjacent, undisturbed habitat (see Table 2-3 and FES 79-17 for detailed breakdown of surface disturbance due to each activity and resulting impacts on wildlife).

There are benefits for wildlife which result from oil and gas activity, but they do not outweigh the adverse impacts. A positive aspect of exploration is the use of abandoned wells for livestock watering wells. These new water sources can also benefit wildlife. Reclamation of abandoned drill pads and roads with grass species in vegetative communities where sagebrush occurs in dense stands creates openings and increases the amount of edge between habitat types. Increasing the amount of edge increases the number of individuals and the diversity of wildlife in the area, because the edge attracts species who favor either habitat type.

#### Aquatic Habitat

Water quality may be degraded by sedimentation and/or toxic materials associated with oil and gas activity (see water resources and vegetation sections, above). Increased silt loads may reduce the wildlife carrying capacity of streams and ponds by interfering with photosynthesis (and the growth of plants) and by changing flow and turbidity characteristics.

Important aquatic habitat occurs in the southern Big Horn Mountains. Blue Creek, Beaver Creek, and Bachaus Creek, and the Middle and North Forks of the Powder River are some of the major perennial streams in the area. Here, steep canyon slopes contribute to the problem of sedimentation. Steep slopes are difficult to reclaim, especially in mountainous areas, where the short growing season prolongs the revegetation process. If roads and other disturbed areas are not completely reclaimed, erosion is certain, and the potential for gully formation is high. Both of these conditions would increase soil erosion and subsequent silt loads in streams. (This is consistent with information presented in the soils section, above. All soil series listed in Table 2-7 show better than a 150% increase in rates of soil loss when slopes increase from 10% to 20%.) The net effect of such increases in stream silt loads would be to smother spawning gravels, increase turbidity, decrease dissolved oxygen, and destroy or reduce overall aquatic productivity.

Spills of toxic substances, such as crude oil and production fluids, can degrade water quality for a period of time depending on the amount and toxicity of the particular contaminant. Direct mortality of fish, aquatic invertebrates, and aquatic plants could result from spills of crude oil which reach streams and reservoirs. This possibility is increased as the size of the spill increases. Spills of crude oil could cause long-term contamination, as an oil-soaked streambed would be the source of continuous release of oil into the stream for a long period of time. Spills of toxic fluids could also render streams unfit as wildlife water sources. This could be highly detrimental to big game and furbearer populations in areas of water scarcity.



Since the locations of new access roads and well sites are unpredictable, as are the frequency, quantities, and sites of accidental spills, impact significance cannot be quantified.

#### Wildlife Populations

Impacts of a dispersed activity, such as oil and gas development, on wildlife populations vary. If a wildlife population is distributed over a large portion of the resource area, than impacts are unlikely to be significant in a regional sense. For example, the loss of 180 pronghorn and 120 mule deer, cited above, represents less than 1% of their total populations in the resource area. On the other hand, any wildlife species which is restricted to a specialized or uncommon habitat can be significantly affected by surface disturbance in that habitat. Examples of the latter group of species are elk, raptors, and some game birds. Because the Bureau of Land Management (BLM) has derived lease stipulations to deal with these special situations, some adverse impacts of oil and gas activity can be averted. However, it is impossible to quantify the residual impacts on any wildlife species, because the exact locations of oil and gas wells to be drilled in the future is not predictable.

Elk. The resource area supports approximately 1,000 elk in winter, 50 in the Fortification Creek area and 700 to 900 in the southern Big Horns (FES 79-17 and personal communication, Roger Wilson, Wyoming Game and Fish Department, December 18, 1979). During the summer, the total number declines by half because many elk migrate to high elevations in the national forest.

Of all the big game animals in the resource area, elk are the most sensitive to and intolerant of human presence and man-made disturbance. Oil and gas activity in their preferred habitat would tend to displace them to other areas; since habitat suitable for elk is limited, displacement may mean death for some of the animals. This is particularly true in winter, a period of physiological stress, when disturbance would mean displacement to areas of sparse cover and forage, higher elevations, deeper snow, and exposure to winds. Elk calving season is another period when disturbance can drive elk to areas of poor cover and/or reduce survival rates of the calves.

The greatest single adverse impact of oil and gas activity within elk habitat would result from construction and upgrading of access roads. This would open up escape cover and feeding areas that were formerly sanctuaries. Two studies in Idaho indicated that access into previously undisturbed habitat resulted in a higher legal harvest and led to long-term declines in elk populations (Thiessen 1976, Leege 1974). Hershey and Leege (1976) found elk use of habitat was disrupted within .25 mile on either side of logging roads in Idaho. Ward (1976) found the same thing to be true of elk in southeast Wyoming. Coggins (1976) stated that high road densities and heavy traffic excluded elk from any areas of escape cover. Perry and Overly (1976) found a significant drop in habitat use near roads compared to similar undisturbed habitats.



The studies mentioned above concluded that construction of roads in elk habitat may not leave enough buffer area between the roads and escape cover. Road density in an oil field could be such that minimum security cover needs are not met. This could especially happen if an oil field were developed over a broad area. Roads may also cut across major trails and thus could inhibit elk movements, leading to over-utilization of some portions of the habitat and reduction in carrying capacity.

Elk habitat considered critical for maintenance of the herds has been identified by the Wyoming Game and Fish Department and is shown on Map G, Appendix. Acreages are shown on Table 2-11.

In Fortification Creek, opening the critical elk habitat to exploration and development would most likely drive the elk from the area. An increased number of improved roads into Fortification Creek would most likely increase the amount of public use. Since escape cover in the area is marginal (mostly juniper trees and rough topography), increased human-wildlife encounters would tend to drive the animals from the area. Increased public access could also increase the amount of poaching. This would seriously jeopardize survival of the elk herd, since the current population has been reduced to around 50 individuals. (The winter of 1978-79 apparently was the cause of the reduction of the herd from around 200 individuals to the current population. It will take a few years of optimum conditions (mild weather, high forage production, etc.) before the herd can return to the desired post-hunting-season population of 200 animals.)

The Ed O. Taylor Game Range, in the southern Big Horns, and the Bud Love, Kerns, and Amsden Creek big game ranges are managed by the Wyoming Game and Fish Department as big game winter ranges, especially for elk. In order to protect the elk from disturbance, BLM has established, through land use planning decisions, protective stipulations for these ranges (see Chapter 1, Proposed Action).

In the southern Big Horn Mountains, outside of the game ranges, there are approximately 50,000 acres of elk winter range designated as critical by the Wyoming Game and Fish Department. There also are approximately 12,000 acres of elk calving range in the southern Big Horns. The 700 to 900 elk which use the winter range constitute 35% of the post-hunting-season population in the southeast Big Horn herd unit, a Wyoming Game and Fish Department management unit. In some years there is interchange of 60 or 100 animals with the elk herd in eastern Washakie County (personal communication, Roger Wilson, Wyoming Game and Fish Department, December 18, 1979). Winter use of the southern Big Horn range depends on the weather. Heavier snows cause the elk to winter in the eastern portions of their winter range, whereas milder winter weather allows much greater freedom of movement.

The areas of the southern Big Horns currently used for wintering and calving are the best suited areas to provide for the needs of the elk. Surface disturbance and human intrusion in critical elk winter ranges and calving areas would force the elk to areas of poorer quality habitat, and overall herd productivity and health would probably decline.



TABLE 2-11

## CRITICAL ELK HABITAT

|                                               | Acres<br><u>Federal Mineral Estate</u> | <u>County</u>    |
|-----------------------------------------------|----------------------------------------|------------------|
| Kerns, Amsden, and Bud Love<br>Big Game Range | 3,840                                  | Sheridan-Johnson |
| Ed O. Taylor Big Game Range                   | 9,670                                  | Johnson          |
| South Big Horns                               | 62,000*                                | Johnson          |
| Fortification Creek                           | 39,040                                 | Johnson-Campbell |
| TOTAL                                         | 114,550**                              |                  |

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\* Approximately

\*\* Or 3.7% of all federal oil and gas estate in the three-county region.

Mule Deer. There are approximately 67,500 mule deer distributed throughout the resource area (Wyoming Game and Fish Department 1979). Currently, there is no mule deer habitat in the resource area designated as critical by the Wyoming Game and Fish Department.

Mule deer are less sensitive to disturbance than elk, but are vulnerable to disturbance occurring on their winter ranges. Traffic, noise, and human harassment near exploration wells and producing fields could cause deer to leave their winter ranges, where food and shelter are available. However, since deer winter use in a particular area depends on snow depth and exposure, adverse impacts would vary, depending on the severity of the winter.

Pronghorn. Pronghorn are the most abundant big game animal in the Buffalo Resource Area at approximately 36,300, which is believed to be more than the area can adequately support; and the Game and Fish Department plans to reduce the herd size to approximately 27,600 by 1983 (ibid.). The overpopulation of pronghorn was caused by a series of mild winters and the loss of habitat to housing and other development. There is no critical pronghorn habitat identified in the resource area.

Pronghorn tend to be the big game animal most adaptable to oil and gas exploration and development. The worst effect of such development on pronghorn is the opening of new roads into previously inaccessible country. This can lead to an increase in poaching losses.

Moose. Less than 100 moose are found in the resource area, in the Big Horn Mountains in Johnson and Sheridan counties (ibid.). Their habitat is mainly centered along perennial streams and ponds in the Bighorn National Forest. There currently is very little, if any, oil and gas exploration taking place in important moose habitat.

Bighorn Sheep. A herd of approximately 30 bighorn sheep lives in the canyon of the Middle Fork of the Powder River, where they are protected from the impacts of oil and gas activity by current BLM land use decisions.

Small Mammals, Furbearers. A list of common species and densities can be found in FES 79-17.

Small nongame mammals are distributed throughout the resource area. They are most affected by loss of food and cover, although blading of drill pads and roads kills some outright. Losses to regional populations caused by oil and gas activity are insignificant.

Most furbearers and small game mammals occur in the riparian and coniferous habitats in the resource area. The most negative impact to furbearers in the riparian habitat comes from oil spills or pipeline leaks. Depending on the severity of the spill, this could lead to direct mortality and loss of habitat, thus reducing overall population levels. Small game, such as cottontails and snowshoe hares, are affected most by the loss of food and cover, if roads or drill pads are built in riparian areas. It is unlikely that oil and gas activity would affect regional populations of small game.

Raptors. A complete list of raptors occurring in the resource area is presented in FES 79-17. Raptor nesting areas are shown on Map H, Appendix.



Favored nesting habitats for raptors are solitary trees in ephemeral streambeds and cliffs. The nesting season is generally the time of highest physiological stress for raptors. Disturbance, even a one-time occurrence, may cause the more sensitive species (eagles; hawks, especially the ferruginous and Swainson's; and the short-eared owl) to abandon their nests. This would most likely occur during egg-laying and incubation stages. Road construction, drill pad construction, or even seismic exploration and pipeline construction within view of the nest could cause nest abandonment. Because raptor nests are built in exposed locations, activity as far as .5 mile away can be seen by the birds and may cause disturbance.

Current land use decisions protect nesting raptors by prohibiting surface disturbance for oil and gas activities within .5 mile of active nests from March 1 to June 30, so that most adverse impacts are averted.

Raptor electrocution on power lines associated with oil field development should not be a problem since the voltage commonly used to provide power is far below the level which causes injury or death (Nelson, unpublished). Also, lines to wells normally originate from transmission lines of higher elevation, and the higher poles are preferred by birds for perches.

Game Birds. Sage grouse are the most common upland game bird in the area. These birds conduct their mating activities on the same lek (strutting ground) every year (see Map H, Appendix). It is estimated that 68% of sage grouse nesting occurs within 1.5 miles of the lek (Wallsted 1975). The birds often appear oblivious to human activity near their lek but are often driven from these areas by too much disturbance. In addition, because the birds and nests are concentrated at a lek, they are highly vulnerable to poaching or surface disturbance.

Sharp-tailed grouse also conduct mating activities at leks and are also susceptible to disturbance. Sharp-tailed grouse are not as common in the area, judging from the fact that far fewer sharp-tailed grouse leks are known (see Map H, Appendix).

BLM prohibits surface occupancy near leks during mating season, so impacts of oil and gas activity are not considered significant.

Mourning doves are common in the area, but their habitat preferences are less restrictive than the two grouse species. For this reason, it is unlikely that oil and gas development would significantly reduce mourning dove populations.

Wild turkeys are found in the resource area but only in very restricted habitat, usually along streams with extensive woody riparian vegetation or in stands of conifers. Adverse impacts to wild turkeys would most likely occur during the nesting season (May 1 to June 30) from road building, drill pad construction, or construction of ancillary facilities, such as pipelines or power lines. To date, little oil and gas development has taken place in turkey habitat.

Waterfowl are limited to the numerous stock ponds in the region and the few perennial streams. These conditions favor puddle ducks. Geese are rarely seen in the region. Adverse impacts to waterfowl



would stem mostly from spills of oil or drilling fluids into streams and reservoirs. The loss of aquatic plants, fish, and aquatic invertebrates would remove the food supply for waterfowl. Ingestion of contaminated plant or animal food could kill waterfowl. Unflagged reserve pits are hazardous to waterfowl, especially during migration, when birds unfamiliar with the area attempt to land and are covered with oil. Except in the case of a major oil spill, impacts to waterfowl would probably be insignificant.

Nongame Birds. In the sagebrush-grass and shortgrass prairie vegetative types there are only five to seven common species (see FES 79-17). The riparian and conifer vegetative types have a higher diversity and density of bird species due to more cover and a greater diversity of food.

Overall adverse impact on these birds is probably insignificant on a regional basis. Seismic exploration has little impact, except right along the line where some ground nests could be destroyed. Road construction and drill pad construction, as well as clearing brush for pipeline construction, destroys some nests. Once production begins, the amount of cleared area remains fairly constant, leading to a reduction in the base population for the life of the oil field. Abandonment restores grass cover, although brush cover takes several years longer to reestablish itself.

Reptiles and Amphibians. Species diversity of these classes of vertebrates is low in northeastern Wyoming, but most species are well distributed (see FES 79-17), and their total numbers are probably not significantly affected by oil and gas activities. Species common to riparian areas would be most adversely affected by oil spills and similar discharges of salt water, drilling fluids, and other toxic substances. Species living in upland areas are directly destroyed by earth-moving equipment during construction of roads and drill pads.

Fish. A list of fish occurring in the Eastern Powder River Basin is found in FES 79-17. A few other species not found in Campbell County occur in the streams originating in the Big Horn Mountains.

Impacts to fish would come from increased silt loads in streams and reservoirs. This would reduce light penetration which, in turn, would cut productivity of aquatic plants. Aquatic plants could be scoured from their substrate by excessive silt loads. This reduce invertebrate populations. Increased silt loads in streams would clog spawning gravels and suffocate eggs of trout and other gravel spawning fish. As noted in the water resources section, many resource area streams are silt laden as a result of natural erosion, and only oil and gas development in steep-sided drainages of the Big Horn Mountains would significantly change sediment levels in streams.

Oil spills, and spills of other toxic substances, would have direct toxic effects on fish and aquatic invertebrates. The entire food chain would be disrupted, and effects of an oil spill into a stream would be long term. Impacts are not quantifiable, and the significance of the damage would depend on the size of the spill.



### Threatened or Endangered Species

Species listed by the U.S. Fish and Wildlife Service as endangered which occur in the Buffalo Resource Area are the black-footed ferret, bald eagle, and the peregrine falcon. As described in the Appendix, Laws and Enforcing Agencies, consultation with the U.S. Fish and Wildlife Service is required prior to federal authorization of any action which could affect an endangered species or its habitat. Consultation will be initiated if field examination determines the presence or possible presence of an endangered species where application has been made for site-specific oil and gas development activity.

Ferrets have been found, historically, in northeastern Wyoming, and there have been sightings, both verified and unverified, within the resource area since 1970 (see Map H, Appendix). Sightings of black-footed ferrets in Wyoming are summarized by Clark (1977). The primary habitat for this species is prairie dog towns. Any prairie dog town should be considered potential black-footed ferret habitat until field investigation can verify the presence or absence of ferrets.

Possible impacts of oil and gas activity to ferrets would be destruction of food and cover, or disturbance caused by human intrusion.

Bald eagles are common winter residents in the resource area. The eagles range freely across the plains in search of carrion or small mammals. The birds usually arrive in northeastern Wyoming in November and leave in March or early April. The arrival and departure dates are strongly dependent upon the weather. Two, and possibly three, communal roosting sites are known: one in Campbell County, one on the Converse/Campbell county line, and one in Johnson County. (In order to protect the birds, the locations of the roosting sites have not been made public.) The two most important characteristics of the communal roost sites are solitude and protection from the weather.

Some research has been done concerning roosting eagles and how they respond to human disturbance. Vian (1971) found that along the Platte River in Nebraska the eagles became alarmed by disturbances .5 mile away. Eagles in South Dakota and Washington prefer to use areas of low recreational activity. Lish (1975) found eagles to be least tolerant of human disturbance at their roosts and most tolerant of disturbance at feeding areas.

Oil and gas development near bald eagle roosts would most likely cause the eagles to abandon the roosts. Other suitable roosting sites may or may not be present in the same general area. The roosts currently in use are the result of several factors which combine to provide the eagles security and protection from the weather. With human intrusion suddenly taking place, the birds might abandon the roosts and leave the area. Since winter is a time of high physiological stress, this could lead to the loss of some birds if they are forced to relocate in less favorable habitat.

Peregrine falcons are occasional visitors to the area, and are usually seen (if at all) during the fall migration season. Hence, adverse impact of oil and gas activity to peregrine falcons is unlikely.



## Cultural Resources

Cultural resources is a general term used to describe all evidence of man's activity. Cultural resources include artifacts (objects made or modified by man), structures, areas of habitation, works of art, natural features that were of importance in human events, and areas where significant human events occurred even though evidence of the event no longer remains.

For convenience, cultural resources are recognized as discrete areas called sites. Cultural resources are located upon the land surface and within the subsurface soil zones. Cultural resource sites are finite in number and cannot be replaced.

Cultural evidence within the Buffalo Resource Area is documented back in time for 12,000 years (Kerr McGee Coal Corporation 1978). Throughout the continuum from this early time until the historic tribes were defeated by the army in the late 19th century, Indians left behind evidence of their presence. This evidence is manifested in campsites, animal kill sites, rock art panels, stone circles, firepits, tool stone quarries, religious areas, and special use areas for vegetal food processing or animal butchering. Sometimes these sites are easily recognized--stone circles, for example. In other sites, artifacts are widely dispersed and assume a very low visibility.

European contact with the indigenous tribes is believed to have occurred in the mid-18th century. Subsequent exploration by trappers, homesteaders, military groups, miners, and ranchers, led to the presence of military forts, trails, homesteads, mines, trading posts, and battlefields.

Site densities, as inferred from a recent sampling inventory of Sheridan and Johnson counties, average 1.6 sites per square mile in these two counties (Reher 1979). Densities are greater in areas that include the foothills and forested portions of the mountains. Here the density is approximately 5 sites per square mile and is suspected as probably being closer to 10 to 15 sites per square mile along canyons with flowing water (Reher 1979). Occurrences of even greater site densities--up to 30 sites per square mile--have been reported for portions of the Red Wall area (Jameson 1977).

Work within Campbell County in a pine break ecozone disclosed a site density of 4 sites per square mile (Reher 1979). Densities are known to be highest along the main watercourses within the Powder River Basin.

All cultural resource values are not regarded as of the same importance. Cultural sites are evaluated regarding their significance. For our purposes, significance is related in two ways. First, the criteria of the Interior Department developed to rate sites for their potential inclusion on the National Register of Historic Places is used. The National Register of Historic Places is a listing of those sites deemed worthy of national recognition and management. These criteria determine whether a site is important from its associations with events that have made a contribution to the



broad pattern of our history or with persons important in our past. If a site embodies a distinctive characteristic of a type period, or method of construction, or represents work of a master, or possesses high artistic value, it would be regarded as significant. The second method of significance assignment addresses research potential. If a site possesses attributes that can answer specific questions or fill gaps in our current knowledge, then a judgment of value can be made.

### Impacts

Vehicle travel across and excavations into the soil for construction causes "primary" impact or direct destruction of cultural values. Collection of artifacts and vandalism of structures and rock art, brought about by the presence of individuals in areas of oil and gas operations, are "secondary" impacts. The Bureau of Land Management (BLM) has identified six impacts to cultural resources resulting from exploration of oil and gas resources. Two of these impacts are beneficial in character.

Impact no. 1 (adverse) is the disturbance of site features, crushing of artifacts, and compression and displacement of near-surface deposits. It occurs during geophysical exploration, transport of equipment, and surveying of locations and rights-of-way. Approximately 800 acres are disturbed annually by seismic activities on federal oil and gas estate (Table 2-3). Additional surface disturbance results from support vehicles which travel off planned seismic lines. There is a possibility that shot holes for seismic exploration could be drilled through buried sites. The impact continues after seismic work or surveying is complete, because the presence of trails encourages off-road vehicle travel by hunters and other recreationists.

Impact no. 2 (adverse) is the removal of artifacts and hence the loss of information. It is a continuous problem of major consequences with long-term effect upon the resources. It is recognized that some people cannot resist the temptation to collect Indian artifacts or pick up and examine cultural evidence when encountered. If people constructing a well location are the first to work in a remote area, they have the opportunity to collect previously undisturbed cultural resources. The impact continues after abandonment, because increased ease of access allows the general public to reach previously inaccessible places.

Impact no. 3, protection of National Register quality sites, is beneficial in character. This impact does not occur until the predrilling period when an intensive cultural inventory is conducted by archeologists, and sites are either evaluated as eligible or identified as potentially eligible. Once identified as potentially eligible for nomination to the National Register, the particular cultural resource is afforded protection in perpetuity or until excavation transforms the physical site into notes, photographs, collections of artifacts and data. There is, however, a possibility that identification of a site as National Register quality may lead to unauthorized collection or vandalism, spoiling the qualities for which it was to be protected.



Impact no. 4, data recovery, is both beneficial and adverse in character. Recovery of data cannot occur until the resource is identified by archeologists during the predrilling period. Although considered beneficial at the time data recovery takes place, the process of excavation is irreversible and ultimately destructive. Current research methods and priorities may pass over sites or potential data within them which would have been important to future research. Such decisions may result in the loss of valuable cultural resource information.

Impact no. 5 (adverse) is the destruction of cultural resources in subsurface deposits. It is of major magnitude and is long term in duration. Disturbance of subsurface deposits may occur in the initial stages of exploration if drainage crossings are bulldozed for seismic equipment. Construction of well site and oil field facilities also poses the threat of unidentified values being destroyed. Untrained individuals would not recognize the more subtle manifestations of human occupation.

Impact no. 6 is the identification of highly visible sites in subsurface deposits. The impact can occur at any time during the various phases of oil and gas exploration and oil and gas field development, when cultural values may be recognized within subsurface deposits. This impact would be adverse if the cultural resource are collected by untrained individuals; it would be considered beneficial if the values are recognized and appropriate officials notified. Subsequent data recovery could be considered both beneficial and adverse as in impact no. 4.

Many National Register or National Register-eligible sites exist in the resource area (see Map I, Appendix). Some of these are protected from surface disturbance by current land use decisions, and others are not (see Chapter 1, Proposed Action and Alternatives). With one exception, these significant sites and their appropriate buffer zones are less than 1 mile in diameter so that oil resources beneath them can be extracted.

The exception is the Outlaw Cave archeological district, which encompasses approximately 12,000 acres on the east slope of the Big Horn Mountains, west of Kaycee. (An archeological district is a geographically defined area possessing a significant concentration, linkage, or continuity of sites, structures, or objects which are united by past events--BLM Manual 8100 (3/6/78); 36 CFR 63.5, Appendix A. The name "district" does not imply eligibility to the National Register of Historic Places.) Parts of the Outlaw Cave archeological district are farther than .5 mile from a place considered suitable for surface occupancy, and therefore would be recommended for no leasing. The Outlaw Cave archeological district includes roughly T. 42 N., R. 84 W., Sections 1, 2, 11, 12, 13, 14, 20, 21, 22, 23, N 1/2 24, N 1/2 26, N 1/2 27, N 1/2 28, N 1/2 29; T. 43 N., R. 83 W., Sections 25, 26, 31, 32, 35, 36.

The Outlaw Cave archeological district is considered highly important to our understanding of the prehistoric use of the northwest plains. Based on inventory work done for BLM, Reher



(1979, page 312) states that the area is eligible for nomination as an archeological district of National Register status, based on the following: the site density (up to 30 sites per square mile) is the highest of several counties; the resource diversity for hunter-gatherers is the highest in the Western Powder River Basin, and probably the entire Powder River Basin; and there are many rock shelters present which possess potential for preservation of stratigraphic sequences (layers of artifacts preserved in chronological order). The shelters can also have large samples of rare materials. (Many rock shelters have been excavated by amateurs with resultant minimal recovery of data. This increases the importance of the remaining ones.) Furthermore, the entire area is important as it is amenable for development for public education regarding cultural resources.

During fiscal year 1980, BLM will seek an official eligibility determination for the district from the Wyoming Consulting Committee, Office of the State Historic Preservation Officer, and nominate the district to the National Register. Because an eligibility determination or nomination does not, of itself, specify the extent or type of protection afforded to the site, BLM will develop a management plan during fiscal year 1981, and funds will be requested to protect the cultural resources in the area. Part of the management plan will undoubtedly deal with mineral resource development.

Opening the Outlaw Cave archeological district to oil and gas leasing with surface occupancy would have beneficial consequences: the information gathered during inventories required for surface disturbance would be valuable, both to researchers and to public land managers.

However, the detrimental impacts would outweigh the beneficial ones. First, leasing critical areas would result in damage from construction activities to unknown subsurface cultural evidence. The high site density in the Outlaw Cave area would definitely increase the risk of site destruction during construction.

Second, based on Reher's findings that a site density of 30 per square mile is realistic for portions of the Outlaw Cave area, we could expect 1.9 sites per 40-acre inventory for oil and gas activity. This density would likely result in requirements for mitigating measures on a regular basis. The focus of mitigation could be to reduce site visibility and/or to excavate those sites directly affected by surface disturbance. Direct results of these actions would be elimination of sites for future research, and financial loss on the part of the oil and gas operator, not only in time but also in costs. In a critical area such as the Outlaw Cave archeological district, that has a large number of sites, mapping and controlled collection of all sites, plus excavation of impacted sites, could easily cost hundreds of thousands of dollars.

A third potential adverse impact would be increased unauthorized collection due to the presence of more people in the area as a result of oil and gas development and the creation of new roads. Unauthorized collection would be particularly appealing and lucrative



in the Outlaw Cave area because site density is relatively high and the cultural resources there are relatively important. In particular, the rock shelters and caves, considered valuable for their undisturbed sequential sediments, would be disturbed more rapidly than at present.

Fourth, nomination of the Outlaw Cave archeological district to the National Register of Historic Places is based partially on overall integrity of the area. The placement of intrusive man-made elements (oil wells, roads, etc.) will reduce the qualifications of this area for the National Register.

## Aesthetics

### Visual Resources

The characteristic natural landscape in the Buffalo Resource Area varies from forested mountains to rolling plains. There are also areas of altered landscape, such as oil fields and urban areas.

Based on the Visual Resource Inventory and Evaluation System (U.S. Department of Interior, Bureau of Land Management Manual 6300), visual resource management (VRM) classes have been identified for the resource area. These classes are delineated on Map J, Appendix. A brief explanation of the VRM system follows; a detailed explanation can be found in the Final Environmental Statement on Eastern Powder River Basin Coal Resources (FES 79-17).

The purpose of the VRM system is to set management objectives for maintaining or enhancing visual resources on public lands. One of five VRM classes is assigned to a given land area based on (1) scenic quality, (2) visual sensitivity, and (3) visual zone (see matrix in Figure 2-3). Scenic quality is rated A--high, B--moderate, or C--low, depending on the presence or absence of water, intrusions, and unusual landforms, and variations in color and vegetation. Visual sensitivity levels are determined by people's concern for what they see. Usually the highest sensitivity areas lie near communities, recreation areas, and heavily traveled highways. There are three visual zones: foreground--middleground (0 to 5 miles from a travel route or observation point), background (from 5 miles to a maximum of 15 miles from an observation point), and seldom seen (along infrequently used roads or beyond 15 miles from an observation point).

Each VRM class describes a different degree of modification which should be allowed in the basic elements of the landscape.

Class I: This class provides for natural ecological changes only. It is applied to primitive areas, some natural areas, and similar situations where activities are to be restricted.

Class II: Changes in any of the basic elements (form, line, color, or texture) should not be evident in the characteristic landscape.

Class III: Changes in the basic elements (form, line, color, or texture) may be evident in the characteristic landscape. However, the changes should remain subordinate to the visual strength of the existing character.

Class IV: Changes may subordinate the original composition and character, but must reflect what could be a natural occurrence within the characteristic landscape.

Class V: Intrusions overlying one of the management classes (I-IV) are significant enough to jeopardize effective management until the intrusions are removed.

The predominant VRM classes in the resource area are III and IV. However, there are several scenic areas which have been rated Class II: the Middle Fork of the Powder River and the Red Wall in southwest Johnson County (see Map J, Appendix). The Bighorn National Forest and the foothills of the Big Horn Mountains are also Class II areas.



|               |   | VISUAL SENSITIVITY LEVEL |     |    |        |    |     |    |
|---------------|---|--------------------------|-----|----|--------|----|-----|----|
|               |   | HIGH                     |     |    | MEDIUM |    | LOW |    |
| SPECIAL AREAS |   | I                        | I   | I  | I      | I  | I   | I  |
| SCENERY CLASS | A | II                       | II  | II | II     | II | II  | II |
|               | B | II                       | III | IV | III    | IV | IV  | IV |
|               | C | III                      | IV  | IV | IV     | IV | IV  | IV |
|               |   | FG                       | BG  | SS | FG     | BG | SS  | SS |
|               |   | VISUAL ZONES             |     |    |        |    |     |    |

NOTE: FG = Foreground - Middleground  
BG = Background  
SS = Seldom Seen

Class I applies only to classified special areas, e.g., Wilderness, Primitive, Natural Areas, etc. This quality standard is established through legislation or policy.

Class V applies to areas identified in the scenery quality inventory where the quality class has been reduced because of unacceptable intrusions.

Figure 2 - 3  
Visual Resource Management Class Determination

Impacts to the visual resource result from man-made additions to or alterations of the natural landscape. Structures such as power lines and pumpjacks and scars made by roads are intrusions; the degree of impact of these intrusions depends on their contrast with the natural landscape and their visibility.

Exploratory drilling and production are the phases of oil and gas development that cause the greatest change in visual resources. For example, if wells in an oil field are spaced evenly every 40 acres, a regular pattern is imposed on an irregular land form, making the intrusions more noticeable; there are approximately 16 wells and 4 miles of access road per section with attendant structures. If the intrusions happen to be located on forested lands, ridgetops, or near highways or residential areas, they are highly visible and their impact is significant.

The presence of each oil well or road temporarily changes the VRM class in its vicinity to Class V (intrusion). Once the well is abandoned, the surface reclaimed, and the vegetation restored, the area reverts to its original VRM class. (Acreages affected by visual intrusions are shown in Table 2-3.) If the abandoned well is not adequately rehabilitated, or if accumulations of litter and derelict equipment are left, adverse visual impacts continue.

The visual intrusions normally associated with oil and gas development are unacceptable from a management standpoint in parts of the resource area where scenic values are high. It is for this reason that land use decisions have been made to protect parts of the Red Wall and Middle Fork areas (see Map K, Appendix and Chapter 1, Proposed Action).

Adverse impacts to visual resources in any VRM class can be reduced by application of stipulations to individual surface-disturbing activities (see Chapter 3).

### Noise

Oil and gas development leads to significant increases in noise levels. Noise produced by equipment constructing roads, drilling wells, or pumping oil is not only annoying (Table 2-12), but may exceed standards set by the Occupational Safety and Health Administration for exposure to noise (Table 2-13). The change in noise level is most noticeable in rural areas where the primary noise source is the wind, but may be most objectionable in or near residential areas.

Where noise sources will be in place for many years, as in the case of well pumps powered by internal combustion engines, and where the noise would disturb nearby residents or alter the natural characteristics of a recreation or special management area, muffling is an acceptable solution. Mufflers can reduce noise levels to 60 dB(A) (normal conversation level) at .25 mile or less, and can be required as a lease or drilling permit stipulation.



TABLE 2-12  
DECIBEL READINGS

| <u>Source</u>                                                     | <u>Noise Level (dB(A)) at the Source</u> |                      |
|-------------------------------------------------------------------|------------------------------------------|----------------------|
| Soft whisper (15 feet)                                            | 0-3                                      | Threshold of hearing |
| Probable rural prairie<br>or wilderness background<br>noise level | 30                                       | Very quiet           |
| Normal conversation                                               | 60                                       |                      |
| Urban freeway                                                     | 75-80                                    | Annoying             |
| Heavy truck                                                       | 90                                       |                      |
| Single-cylinder<br>pumpjack engine<br>(unmuffled)*                | 95-100                                   |                      |
| Diesel engine for<br>exploratory drilling<br>(unmuffled)**        | 100-112                                  |                      |
| Thunderclap                                                       | 120                                      |                      |
| Jet takeoff                                                       | 140                                      | Threshold of pain    |

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Source: U.S. Department of the Interior, Geological Survey, 1979.

Note: The most commonly used measure of sound--the decibel (dB) is a logarithmic function; i.e., decibels are not directly additive. A small change in decibel would be a major change in noise intensity. For example, a sound level of 64 dB is twice as intense as a level of 60 dB. The "A" scale of weighing decibels most closely approximates human hearing; therefore decibels on the "A" scale (dB(A)) are used to indicate sound levels.

The distance from the sound source is a major determinant in the perception of various sounds. Theoretically, noise drops off 6 dB(A) for every doubling of distance from the source. Actual measurements of noise generated by diesel engine were 102 dB(A) at the exhaust pipes, 75 dB(A) at 400 feet, 64 dB(A) at 900 feet, and 60 dB(A) at 1,500 feet (personal communication, Gary Roggow, Davis Oil Company, October 9, 1979).

\* Personal communication, Earl Spieles, Marathon Oil Company, October 19, 1979.

\*\* Personal communication, Gary Roggow, op. cit.

TABLE 2-13

## STANDARDS FOR OCCUPATIONAL EXPOSURE TO NOISE

| <u>Duration of Exposure<br/>Per Day (Hours)</u> | <u>Maximum Sound Level<br/>(dB(A))</u> |
|-------------------------------------------------|----------------------------------------|
| 8                                               | 90                                     |
| 6                                               | 92                                     |
| 4                                               | 95                                     |
| 3                                               | 97                                     |
| 2                                               | 100                                    |
| 1½                                              | 102                                    |
| 1                                               | 105                                    |
| ½                                               | 110                                    |
| ¼ or less                                       | 115                                    |

Source: U.S. Department of Interior, Fish and Wildlife Service 1978.



## Recreation Resources

More than 65% of the land surface in the Buffalo Resource Area is privately owned. Consequently, less public land is available for outdoor recreation than in some other parts of Wyoming, and access to it is limited. Recreational pursuits in the resource area are unorganized, with emphasis on individual activities, such as hunting, fishing, camping, hiking, skiing, and snowmobiling. A more detailed account of recreation resources in the area can be found in the Final Environmental Statement on Eastern Powder River Basin Coal Resources (FES 79-17).

There are several areas of special interest in the resource area. The City of Gillette has a recreation area leased from the Bureau of Land Management under the Recreation and Public Purposes (R&PP) Act (T. 49 N., R. 72 W., Section 12, NE 1/4 SW 1/4). An R&PP lease is currently being processed for Sheridan (T. 56 N., R. 85 W., Section 14, N 1/2, N 1/2 S 1/2, S 1/2 SW 1/4).

Other special areas (Map K, Appendix) are: (1) the Red Wall Area, a natural landmark with high scenic, wildlife, and cultural values; (2) the Fortification Creek Area, an area of high scenic values and fragile watershed; (3) the Middle Fork Management Area, an area of high scenic, wildlife, and recreational values; (4) the Little Powder River Area, being developed as an environmental education area; (5) Dry Creek Petrified Forest (T. 51 N., R. 80 W., Section 31, SE 1/4 NW 1/4), being developed as an environmental education area; (6) the Spring Creek Area (T. 55 N., R. 72 W., Section 29, SW 1/4 NW 1/4, N 1/2 SW 1/4, Section 30, NE 1/4 SE 1/4), also being considered as an environmental education area; and (7) Pumpkin Buttes (North and South Middle Pumpkin Buttes), an area of high scenic, geologic, and cultural significance.

## Impacts

Impacts from oil and gas activities affect a wide range of recreational pursuits from sightseeing to hunting. Noise, visual intrusions, and odors reduce the quality of the recreational experience. Within oil fields, hazards such as noxious fumes, heavy equipment, and potentially hazardous chemicals are present. At the extreme, these factors will eliminate a site as a possible recreation area for many people.

Access roads for drilling locations have resulted in major impacts to recreation. On the one hand, they have opened up previously inaccessible areas to the recreationist (even though many of these roads are under private control). Increased access is particularly beneficial to hunters.

On the other hand, to those groups of recreationists enjoying the sense of solitude the back country can offer, increased access and hence traffic detracts from the quality of their experience.

Increasing opportunities to reach remote areas can also result in increased off-road vehicle activity. This activity contributes to

surface disturbance, particularly in areas of fragile soils, or to disturbance of wildlife.

Elimination of wildlife habitat and possible oil spills into fishing waters may also reduce recreation opportunities.

Current land use planning decisions prevent impacts to recreation resources in some of the special areas identified above (see Chapter 1, Proposed Action). In other cases, site-specific stipulations to protect water resources and wildlife eliminate some of the secondary adverse impacts to recreation. Impacts remaining are hard to quantify, because (1) the location of future oil and gas development is largely unpredictable, and (2) as noted above, impacts may be considered beneficial or adverse, depending on personal preference.



## Wilderness

The Federal Land Policy and Management Act of 1976 (FLPMA) is Congress' basic guideline to the Bureau of Land Management (BLM) for management of public lands. Section 603 of this law directs the Bureau to review all public land roadless areas of 5,000 acres or more having wilderness characteristics; to determine their suitability or nonsuitability for wilderness designation; and to report these suitability recommendations to the President no later than October 21, 1991. The President must then report his final recommendations to Congress within 2 years and Congress will decide if any area becomes wilderness or not.

There are presently three areas in the Buffalo Resource Area that are being intensively inventoried by BLM for wilderness characteristics. They are Gardner Mountain (18,440 acres), North Fork Powder River (15,000 acres) and Fortification Creek (33,280 acres). Any leases in these three areas require a special stipulation to assure that wilderness suitability is not impaired, as defined by BLM's Interim Management Policy and Guidelines for Lands Under Wilderness Review (December 1979).

The wilderness inventory in these three areas is scheduled for completion in 1980. If it is determined that any or all of these areas lack wilderness characteristics, the lease stipulation would no longer be applied. However, if any or all of these areas are determined by BLM to be wilderness study areas, the stipulation would be used until Congressional decision on the status of the area(s).

## Mineral Resources

Important minerals in the Buffalo Resource Area are coal, oil and gas, uranium, bentonite, sand and gravel, and scoria. The production of oil and gas does not significantly conflict with the mining or development of any other mineral, except coal.

Federally owned coal and oil and gas are leasable minerals--one must acquire federal leases and pay the government royalty fees to extract them. The Bureau of Land Management (BLM) has created some potential conflicts by leasing oil and gas on areas which are part of federal coal leases and, in some cases, operating coal mines. If coal is to be mined where there is a producing well, the well would probably be plugged below the coal-bearing formation, the coal mined, the land recontoured, and then the well reopened. The time the well is out of production would vary, but average 3 years. To date, all producing wells on coal leases or preference right lease applications are outside the areas being mined, so the workability of the system has not been tried.

Section 3100.4 of 43 CFR states: the granting of a permit or lease for the prospecting, development, or production of deposits of any one mineral will not preclude the issuance of other permits or leases for the same land for deposits of other minerals with suitable stipulations for simultaneous operation, nor the allowance of applicable entries, locations, or selections of leased lands with a reservation of the mineral deposits to the United States.

However, to allow the orderly development of multiple mineral resources, and to avoid unnecessary expense to the mineral lessees, simultaneous extraction of coal and oil and gas should be avoided. It is recommended that oil and gas leasing be deferred on any area covered by an approved coal mining plan on an existing federal coal lease as shown on Map L, Appendix. However, a .5-mile-wide area inside and bordered by the mining plan boundary could be leased with no surface occupancy, because those oil and gas reserves can be extracted from outside the coal mining area. Conversely, federal coal within producing oil and gas fields would not be considered for potential leasing until economic recovery of the oil and gas is complete. (The latter restriction is being applied by BLM during the land use plan amendment process delineating lands acceptable for further consideration for coal leasing.)

It is further recommended that oil and gas leases issued on lands wholly or partly covered by federal coal leases without approved mine plans, by preference right lease applications, or where the potential for future coal leasing exists have a special stipulation attached, alerting the lessees to potential mineral conflicts.

In recent years, the standards for oil field roads have improved. The migration of oil and gas activity into rougher topography has caused access roads to be constructed on steeper grades. Cleaner and neater working areas on the producing locations and around tank batteries are being provided. The foregoing three items have brought about the accelerated use of surfacing material--scoria and sand and



gravel. Sources for these materials have been areas of privately owned minerals or areas of federally owned minerals. Since 1975, BLM has issued seven sale contracts for mineral materials to be used as surfacing material in oil fields in the Buffalo Resource Area. Each sale involved an average of 10,000 cubic yards and 5 acres. However, sand, gravel, and scoria are often removed from federal mineral estate without authorization or payment. Over the past 5 years, an average of two trespass cases have been discovered annually. In order to reduce the number of mineral material trespass cases and the number of man-hours spent investigating them, mineral material disposal plans are being prepared for the resource area. Once the disposal plans are approved, sand, gravel, and scoria would be available for sale at specified sites without the delay necessary for case-by-case environmental analysis and paperwork.

## Ranching

The majority of the Buffalo Resource Area is used for livestock grazing. Because of edaphic (soil-related) and climatic limitations, irrigated and dryfarmed land accounts for only 2% and 3% of the total agricultural land, respectively. Farmed land is usually associated with ranching operations. The average agricultural operation in the resource area is a 5,749-acre livestock ranch which supports about 260 animal units (one animal unit consists of one cow and calf or five sheep) year-round (see Table 2-14).

Earnings in the agricultural sector have declined in the last decade in relative importance in all three counties in the resource area (see Table 2-15); approximately 2.4% of the area's total income is attributable to farming and ranching. However, the importance of agricultural production is not indicated by dollar figures: for example, Wyoming ranks second of all states in stock sheep production, and Johnson County ranks second in the state (see Table 2-16).

Seismograph exploration can affect the ranching operation in a variety of ways. The biggest problem results from fence damage or gates being left open by seismograph crews, causing livestock to drift and mix with neighboring herds. Heavy trucks and equipment may cause damage to existing cattleguards. Noise from seismograph explosive charges may be irritating to both livestock and ranchers. Since notices of intent and performance bonding for geophysical work are required only if any part of the proposed lines cross federal surface, and since there is relatively little federal surface in the resource area, the Bureau of Land Management (BLM) is informed of few of the cases of damage, and hence cannot quantify the above impacts.

Ranching operations can be adversely affected by construction of access roads and drill sites. Direct losses of livestock forage can be measured in terms of animal unit months (AUMs)--the amount of forage required for one cow and calf or five sheep for one month. On high production rangeland, approximately one AUM per mile of road and one AUM per drill site can be lost, on a short-term basis, due to direct impacts. However, oil and gas activity on federal mineral estate impacts only a small percentage of the available forage located in the resource area (see Table 2-17).

The Buffalo Resource Area currently has 415 grazing lessees, ranchers who lease federal surface for livestock grazing and pay grazing fees, based on AUMs available. Existing grazing lease capacities are determined by a 20-year-old range survey. BLM has the authority, under 43 CFR 4110.3-2, to make adjustments to grazing leases, but the basic problem lies in the lack of manpower to conduct field examinations and assess AUM damages resulting from oil and gas activities on federal surface. Therefore, BLM makes adjustments only upon request of the lessees, and no determination has been made as to the actual number of individual operators incurring AUM losses due to oil and gas activities.



TABLE 2-14

## RANCH STATISTICS

|                 | No. of Ranchers | Average Size<br>(acres) | Average Cropland<br>per Ranch<br>(acres) | Average Irrigated<br>Land per Ranch<br>(acres) | Average Woodland<br>per Ranch<br>(acres) |
|-----------------|-----------------|-------------------------|------------------------------------------|------------------------------------------------|------------------------------------------|
| Campbell County | 479             | 6,408                   | 136                                      | 5                                              | 16                                       |
| Johnson County  | 273             | 7,803                   | 120                                      | 152                                            | 20                                       |
| Sheridan County | 497             | 3,036                   | 238                                      | 122                                            | --                                       |

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Source: U.S. Department of Commerce, Bureau of the Census 1969.

TABLE 2-15

## EARNINGS IN THE AGRICULTURAL SECTOR

1970 and 1975

(Thousands of Current Dollars as a Percent of Total County Earnings)

|                 | <u>1970</u>   | <u>1975</u>  |
|-----------------|---------------|--------------|
| Campbell County | 5,482 (13.9%) | 462 (0.6%)   |
| Johnson County  | 4,747 (30.8%) | 1,405 (6.3%) |
| Sheridan County | 6,335 (13.0%) | 2,192 (3.1%) |

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Source: U.S. Department of Commerce, Bureau of Economic Analysis 1977.



TABLE 2-16

RANK OF CAMPBELL, JOHNSON, AND SHERIDAN COUNTIES  
IN WYOMING AGRICULTURAL PRODUCTION FOR 1977

|              | <u>Campbell County</u> | <u>Johnson County</u> | <u>Sheridan County</u> |
|--------------|------------------------|-----------------------|------------------------|
| Stock sheep  | 5                      | 2                     | 14*                    |
| All cattle   | 6                      | 9**                   | 5                      |
| Winter wheat | 4                      | 11                    | 7                      |
| Barley       | 6                      | 15                    | 5                      |
| Oats         | 9                      | 12                    | 5                      |
| All hay      | 15                     | 11                    | 8                      |

---

Source: Wyoming Crop and Livestock Reporting Service, no date.

Note: There are 23 counties in Wyoming. Wyoming ranks, in national production, 2nd in stock sheep, 32nd in all cattle, 25th in winter wheat, 10th in barley, 25th in oats, and 26th in all hay.

\* Tied with Park County.

\*\* Tied with Crook County.

TABLE 2-17

## ANIMAL UNIT MONTH LOSSES TO OIL AND GAS ACTIVITY

|                                                                    | 1979           | 1985           | 1990           |
|--------------------------------------------------------------------|----------------|----------------|----------------|
| Total acres disturbed and unreclaimed on federal mineral estate    | 9,842          | 13,002         | 15,256         |
| Approximate number of AUMs available in resource area*             | 900,000        | 900,000        | 900,000        |
| AUMs lost and percentage of total AUMs available in resource area. | 1,230<br>(.1%) | 1,625<br>(.2%) | 1.907<br>(.2%) |

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\* Assuming an average of 8 acres per AUM.



Grazing lease adjustments can be made for actual livestock forage losses resulting from the development of access routes, drill pad construction, oil spills, and saltwater spills, causing a permanent measurable loss of vegetation. Additional complaints from grazing lessees involve the deterioration of existing livestock forage for which they have paid grazing fees. Such damages occur as a result of dust from roads, weed infestations, and improper rehabilitation techniques. Indirect impacts causing forage deterioration cannot be easily measured. A systematic approach to the evaluation of permanent livestock forage losses would prove beneficial in accurately determining the amount of livestock forage available to grazing lessees. This would alleviate the problem of paying for livestock forage that is not there.

Vehicle use on access roads can be hazardous to livestock. Heavy vehicular traffic increases the possibility of injury or death to livestock. Since this occurrence is unpredictable, the impact cannot be quantified.

Dust raised from frequently used roads can be a nuisance to the rancher if near the ranch house. Dust can also affect the palatability of forage for as much as .25 mile from the road. Rain will, however, wash the dust from the forage periodically. The problem of dust is a recognized problem, affecting livestock distribution; however, the impacts are relatively intangible.

The noise resulting from oil and gas activity may cause livestock to be driven away from the area, and possibly cause overgrazing in other parts of the pasture. Drilling in or near a lambing or calving pasture during the spring is especially disturbing for the mothers and newborn animals. Noise can also become a nuisance to the landowner (see section on noise, above).

During drilling and production phases the following hazards to livestock rarely may exist: livestock can become mired in mud or possibly drown in unfenced reserve or production pits, or they may drink water contaminated with toxic chemicals.

Livestock forage losses also occur due to accidental oil and saltwater spills. Such spills follow drainages and can affect the most productive areas of the range.

Noxious weed invasions on abandoned sites prevent the growth of useful forage. If abandoned sites are not properly rehabilitated, it means additional time periods in which AUMs are lost from production. Unseeded sites can also induce erosion and increase silt loads in drainages, affecting forage production and availability.

If abandoned sites are reseeded with grass mixtures and left unfenced, they may be heavily grazed by livestock which prefer the new tender vegetation over surrounding native vegetation. This impairs seedling establishment.

There are some benefits to the livestock operation from oil and gas activities. First, usable water may be discovered and developed for livestock use. (As noted in the wildlife section, it may benefit other animals, too.) Lack of water is a limiting factor to livestock grazing within much of the Buffalo Resource Area. Occasionally,



while drilling for oil, an oil company encounters an underground water supply. If this happens to be in an area lacking sufficient water for livestock, and if the well is to be abandoned, such a discovery is a convenient opportunity for water development.

Water discoveries have to be evaluated on a case-by-case basis as to economic feasibility, but generally water no more than 400 feet deep is the most economical to the livestock operator. Such a well may be acquired by the surface owner from the oil and gas operator. If so, the well is cemented below the water-bearing formation and then completed as a water well.

On federal surfaces, there is a problem with such water well conversion possibilities because the budgeting process for range improvements requires a minimum of 2 years. Such a budgeting system makes it difficult to convert and develop wells, because the decision to convert the well must be made and the well cased in a short period of time--72 hours to 2 weeks. This is enough time to contact the livestock operator and make the determination as to the need for livestock water, but does not give BLM enough time to authorize funds for the conversion.

BLM develops less than five water wells on federal surface in the Buffalo Resource Area annually. In the past, these have been drilled specifically for water, rather than converted. In the last 2 years, however, two wells have been converted on federal surface. The number of annual well conversions on private surface is unknown, but thought to be greater.

The second beneficial impact is the development of roads and utilities. Oil field road development improves the rancher's access, especially since many of these roads are maintained during winter months. Runoff from access roads increases moisture available to surrounding vegetation. Relief diversion ditches are also used to supply water to dugout pits and small livestock reservoirs. Finally, electric power development in the area may increase range improvement/development possibilities, thus benefiting the ranch operator.



## Lands

For every producing well, there must be a service road, a supply of power for the pump, and a means of transporting the oil and/or gas to a processing facility. Unless a field is unitized (an arrangement whereby different producers share facilities), the oil companies make little effort to coordinate the placement of their facilities. As a result, existing fields in the resource area are tangles of roads, tank batteries, pipelines, and, if electric power is used for the pumps, power lines (Figure 2-4). Although Bureau of Land Management (BLM) land use decisions specify that new rights-of-way follow previously existing corridors, roads, power lines, and pipelines serving individual wells cannot always be restricted to corridors. In addition, power lines serving coal and uranium mines sometimes cross oil fields, contributing to the congestion.

### Transportation

In established fields, two methods of transportation of oil can be used: pipeline or truck. The oil companies prefer pipelines, because they require little maintenance or monitoring and are hence less expensive to operate. Pipelines are also preferable from the land manager's point of view, since there are no noticeable impacts (except in the case of leaks or breakage) once the lines are buried and the rights-of-way are rehabilitated.

Controlling the proliferation of pipelines is difficult. In order to minimize surface disturbance, it is preferable to keep main gathering lines parallel and adjacent to primary roads into the oil fields, with short lines running to each well. However, because oil production must be metered, oil companies usually will not share a pipeline; this means that two or three equivalent pipelines often lie side-by-side, resulting in two or three times the surface disturbance. BLM control of pipeline placement is confounded by the large percentage of private land in the resource area, where no control is possible. (Some industry representatives at the oil and gas workshop on June 5, 1979, stated that in order to avoid processing delays for a right-of-way on federal surface, they choose pipeline routes over private surface; one result may be additional surface disturbance.) Some pipelines are laid on federal surface in trespass, without authorization or stipulations for construction or rehabilitation. This aggravates surface damage.

Truck transportation inevitably causes more undesirable impacts than the use of pipelines: these include surface damage, which can be severe in wet weather; dust and exhaust emissions; and the potential for vehicle accidents.

The development of roads, like that of pipelines, is difficult to control. An oil company is required to obtain a temporary use permit or right-of-way for a road crossing public surface to a well on private land. This presents a problem, in that the general public, ranchers, and personnel from any number of other mineral development companies can use the road, but one company is saddled with the



expense of survey, construction, and maintenance. Some roads are, therefore, constructed in trespass. Where a road must cross private surface, the oil company pays rent to the surface owner, and the road is placed to fulfill the needs of oil development and to serve the surface owner, rather than to avoid environmental damage.

Although most roads in oil fields are private, estimated use of them breaks down as follows: oil field personnel 85%, surface owners 10%, and recreational use 5%. Hunters, sightseers, and others may mistake private roads for public, because construction standards are equivalent to county roads, and because the roads are well traveled. Some people, of course, take advantage of any trail (even pipeline routes at drainage crossings) to exercise their off-road vehicles; this counteracts rehabilitation/revegetation efforts and effectively increases the number of roads criss-crossing the land.

The counties are reluctant to dedicate even well-constructed private oil field roads for public use because of the cost of maintenance, although Campbell County is less hesitant than Johnson and Sheridan counties, because its mineral revenue receipts are greater. (Indeed, oil company maintenance of public roads is sometimes better than counties can afford.)

The passage of heavy oil and gas exploration and drilling equipment can damage existing public roads and bridges. Although Wyoming statutes provide for the repair of damage to public highways at the cost of the people responsible for the damage, responsibility cannot always be determined.

#### Power Supply

It is estimated that less than 10% of the oil well pumps in the resource area are powered by electric motors (personal communication, Glen Blakely, Inexco, August 13, 1979), rather than by internal combustion engines. Although electric motors are relatively quiet and require less maintenance, they are also more expensive to run (internal combustion engines are often fueled by casinghead gas, produced with the oil), and the costs of installing a power line may be prohibitive. Therefore, only those wells within 1 mile of existing power lines are likely to be electrified, and then only if the power supply has not been committed to other customers. Power distribution lines, where they occur, contribute to the visual confusion of oil development; and controlling their placement is as difficult as for pipelines.

Internal combustion engines do not contribute to the maze of rights-of-way in oil fields; however, they require maintenance and hence use of roads in all sorts of weather. The noise produced by internal combustion engines may also preclude or limit other land uses (see section on aesthetics, above).







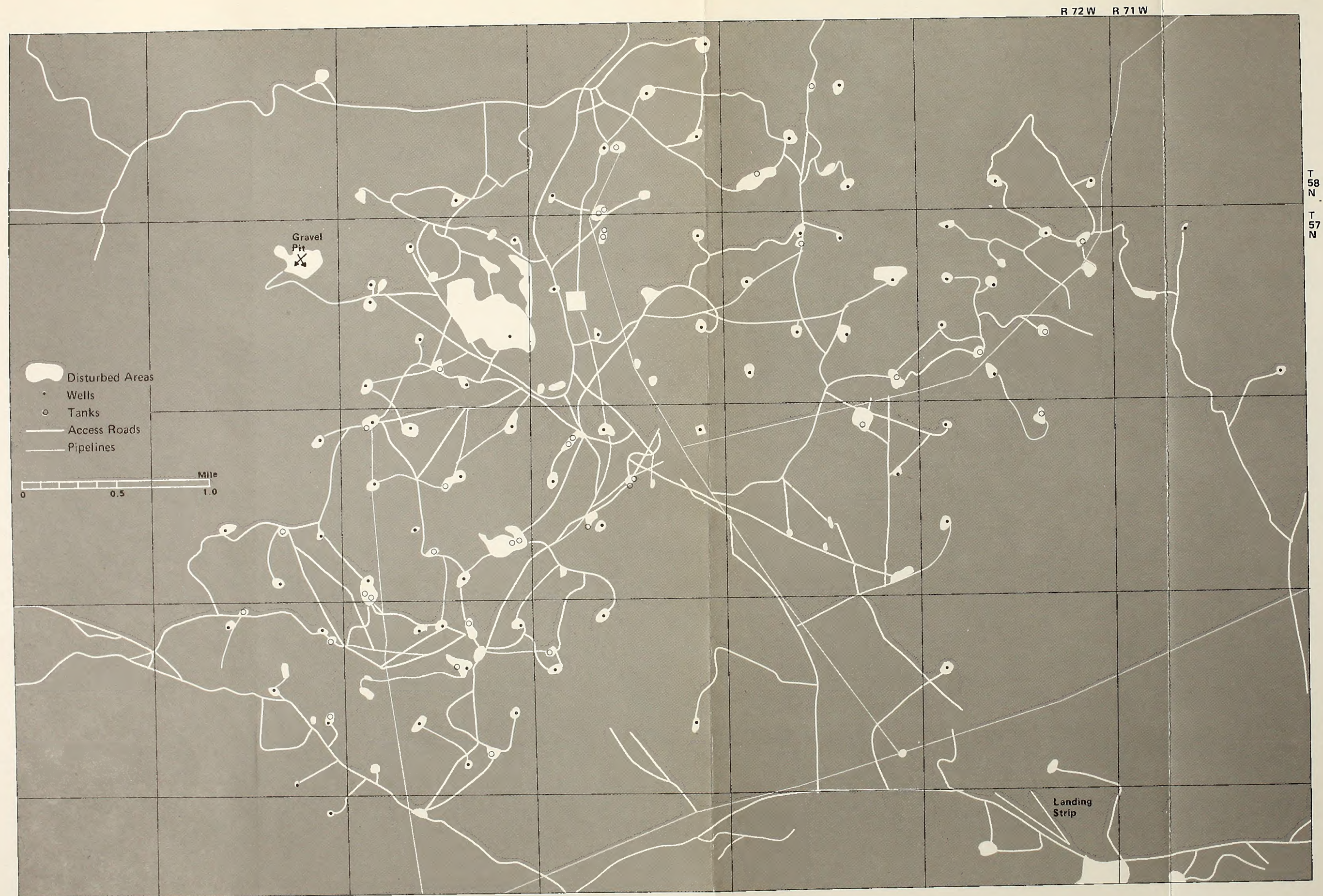


Figure 2 - 4  
Roads, Locations, and Pipelines in the Ute Field  
Campbell County





## Socioeconomics

Much of the following information was derived from the Final Environmental Statement on Eastern Powder River Basin Coal Resources (FES 79-17), which contains detailed descriptions and projections of population, employment, income, housing, and community services for the three counties in the Buffalo Resource Area.

Traditionally, the Buffalo Resource Area, like most of northeastern Wyoming, has been ranching country. Many of the ranches in this area were among the last homesteaded in the United States, and for much of the last century, ranching has been the principal way of life for the people of the area (Massey 1977). The scattered small towns were established to meet the needs of the ranchers; population and economic growth were slow.

Beginning in the 1950s, development of petroleum resources led to a series of economic booms, the most recent and notable of which occurred in Campbell County from 1960 to 1970. The booms resulted in dramatic short-term growths in employment and population, temporarily overtaking public services and housing in Gillette, but producing little change in other parts of the resource area (see Table 2-18).

Oil and gas booms were often followed by busts--as drilling and development were completed, contractors and oil field workers had to find employment elsewhere. Temporary high unemployment rates, depressed real estate values, and unused space in schools and public facilities often followed. Since 1970, however, oil and gas employment and rates of development have remained relatively stable; rapid growth in other parts of the economy, notably coal and construction, has masked any fluctuations.

In the early 1970s, increased coal mining in Campbell and Sheridan counties (as well as in nearby parts of Montana) caused the resource area's population to grow more rapidly (see Table 2-18). With the national demand for low-sulphur, strippable coal growing, there is no question that coal production in the resource area, particularly in Campbell County, will also increase; only the magnitude and rate of development are uncertain. Production predictions for the resource area range from 200 to 300 million tons per year by 1990. (Annual production in 1978 was 30.7 million tons (Goodier and Hoffman 1979).) Corresponding population forecasts range from 83,000 to 92,000 by 1990, and Campbell County is expected to bear the brunt of the population increase (Gladstone 1979; U.S. Department of Interior 1979 (FES 79-17)). The consensus is that the rate of oil and gas exploration and development will remain stable, declining in relative economic importance over the next 10 years, and contributing only a small part to the overall future growth in the resource area (Gladstone Associates 1976 and 1979, Goodier and Hoffman 1979, and Harbridge House, Inc. 1977).

The development of energy minerals tends to be cyclic, depending on the vagaries of national and international policies and economics. It is unlikely, however, that future changes in the oil and gas industry alone would affect the overall economy of the resource area



TABLE 2-18

## BUFFALO RESOURCE AREA POPULATION

|                 | <u>1950</u>   | <u>1960</u>   | <u>1965</u>   | <u>1970</u>   | <u>1975</u>   | <u>1978</u>   |
|-----------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Campbell County | 4,839         | 5,861         | 10,600        | 12,957        | 13,090        | 26,080        |
| Johnson County  | 4,707         | 5,475         | 6,200         | 5,587         | 5,728         | 6,803         |
| Sheridan County | <u>20,185</u> | <u>18,989</u> | <u>18,000</u> | <u>17,852</u> | <u>19,924</u> | <u>22,501</u> |
| TOTAL           | <u>29,731</u> | <u>30,325</u> | <u>34,800</u> | <u>36,396</u> | <u>38,742</u> | <u>55,384</u> |

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Source: Wyoming Department of Administration and Fiscal Control 1977;  
U.S. Department of Interior 1979 (FES 79-17).

as they have in the past: the economies of all three counties are sufficiently broad-based to absorb fluctuations in oil and gas employment and income. Furthermore, it is expected that new field discoveries will keep pace with the depletion of older fields, so no significant increases or decreases in oil and gas employment will occur.

### Life-styles

In the past, all northeastern Wyoming communities shared a rural, agrarian way of life. Cultural diversity is currently being created by mineral development, industrialization, and a growing tourism industry. Although this diversity is particularly noticeable in Gillette, ramifications of the changing life-style are evident throughout the region. Conflicts have arisen between (1) traditional rural agrarian attitudes and values, and the new urban industrial attitudes and values, and (2) the individual's personal freedoms, values, and attitudes, and the needs, values, and attitudes of the mass society. A detailed discussion of attitudes and life-styles in northeast Wyoming today can be found in the FES 79-17, Chapter 2, Socioeconomic Conditions.

It is important to point out in an environmental assessment of oil and gas development, that the life-style of northeast Wyoming, and the rest of America, is controlled in part by the availability of petroleum and its derivatives. The ways we make our livings, our standard of living, and even our health are influenced by petroleum products. Fuels for transportation, heating, and industry are the most obvious examples; but organic and inorganic chemicals, greases, tar, waxes, plastic, synthetic fibers and fabrics, fertilizer, paint, soil stabilizers, medicines, blood filters, cosmetics, and film are all made from oil or natural gas derivatives.

### Employment and Income

The changing importance of various economic sectors in the resource area is illustrated by changes in employment and earnings (Tables 2-19 and 2-20). From the 1800s until the early 1960s, agriculture represented approximately 50% of total wage and salary income, while mining (oil, gas, and coal) represented about 10%. By 1968, employment and income in the minerals industry (almost entirely oil and gas) surpassed that in agriculture; and in 1977, agriculture showed a further decline in relative importance, representing 3% of employment and 3% of income, whereas mining represented 12% and 25%, respectively. In 1977, approximately 46% of the mining employment and income was attributed to coal and 54% to oil and gas.

The influence of energy minerals development and of the related construction and services industries is seen in the low unemployment rate for the resource area. In July 1979, the unemployment rate for the three counties averaged 2.0%, compared with 2.4% for Wyoming, and 5.7% nationwide (U.S. Department of Commerce 1979).



TABLE 2-19

WAGE AND SALARY EMPLOYMENT BY COUNTY  
(Number of Employees and as a Percent of Total Employment)

|                       | <u>Campbell County</u> | <u>Johnson County</u> | <u>Sheridan County</u> |
|-----------------------|------------------------|-----------------------|------------------------|
| <u>1968</u>           |                        |                       |                        |
| Agriculture           | 142 (3%)               | 159 (7%)              | 340 (4%)               |
| Construction          | 294 (7%)               | 126 (5%)              | 609 (8%)               |
| Government            | 455 (11%)              | 468 (20%)             | 1,717 (22%)            |
| Mining (all minerals) | 708 (17%)              | 170 (7%)              | D*                     |
| Trade/Service         | 1,209 (29%)            | 523 (22%)             | 2,398 (31%)            |
| Other**               | 1,297 (32%)            | 905 (38%)             | D*                     |
| TOTAL                 | 4,105                  | 2,351                 | 7,699                  |
| <u>1973</u>           |                        |                       |                        |
| Agriculture           | 190 (3%)               | 203 (9%)              | 418 (5%)               |
| Construction          | 507 (9%)               | 105 (4%)              | 521 (6%)               |
| Government            | 1,024 (19%)            | 551 (23%)             | 2,257 (27%)            |
| Mining (all minerals) | 943 (17%)              | 158 (7%)              | 98 (1%)                |
| Trade/Service         | 1,474 (27%)            | 573 (24%)             | 2,703 (32%)            |
| Other**               | 1,365 (25%)            | 794 (33%)             | 2,460 (29%)            |
| TOTAL                 | 5,503                  | 2,384                 | 8,457                  |
| <u>1977</u>           |                        |                       |                        |
| Agriculture           | 169 (1%)               | 177 (7%)              | 383 (4%)               |
| Construction          | 2,723 (24%)            | 180 (7%)              | 794 (8%)               |
| Government            | 1,045 (9%)             | 566 (21%)             | 2,313 (23%)            |
| Mining (all minerals) | 2,450 (22%)            | 163 (6%)              | 247 (2%)               |
| Trade/Service         | 2,893 (26%)            | 693 (26%)             | 3,569 (36%)            |
| Other**               | 1,995 (18%)            | 887 (33%)             | 2,585 (26%)            |
| TOTAL                 | 11,275                 | 2,666                 | 9,891                  |

Source: U.S. Department of Commerce, Bureau of Census and Economic Analysis.

\* Not shown to avoid disclosure of confidential information. Data included in totals.

\*\* Includes utilities, transportation, manufacturing, and proprietorships.

TABLE 2-20

EARNINGS BY SECTOR  
(Thousands of Dollars and as a Percent of Total Earnings)

|                       | <u>Campbell County</u> | <u>Johnson County</u> | <u>Sheridan County</u> |
|-----------------------|------------------------|-----------------------|------------------------|
| <u>1950</u>           |                        |                       |                        |
| Agriculture           | 4,497 (59%)            | 2,596 (43%)           | 4,221 (17%)            |
| Construction          | D*                     | 393 (7%)              | 1,925 (8%)             |
| Government            | 466 (6%)               | 447 (7%)              | 3,387 (14%)            |
| Mining (all minerals) | 73 (1%)                | 76 (1%)               | D*                     |
| Trade/Service         | 1,702 (22%)            | 1,676 (28%)           | 7,920 (32%)            |
| Other**               | 866 (11%)              | 811 (14%)             | D*                     |
| TOTAL                 | <u>7,604</u>           | <u>5,999</u>          | <u>25,070</u>          |
| <u>1968</u>           |                        |                       |                        |
| Agriculture           | 3,469 (14%)            | 2,793 (24%)           | 3,115 (8%)             |
| Construction          | D*                     | 1,078 (9%)            | 5,437 (14%)            |
| Government            | 2,056 (8%)             | 2,335 (20%)           | 9,740 (25%)            |
| Mining (all minerals) | 6,278 (26%)            | 1,332 (11%)           | D*                     |
| Trade/Service         | D*                     | 2,856 (24%)           | 12,204 (31%)           |
| Other**               | D*                     | 1,443 (12%)           | D*                     |
| TOTAL                 | <u>24,211</u>          | <u>11,837</u>         | <u>38,960</u>          |
| <u>1973</u>           |                        |                       |                        |
| Agriculture           | 6,345 (14%)            | 6,254 (31%)           | 8,095 (13%)            |
| Construction          | 5,946 (13%)            | 1,547 (7%)            | 6,421 (10%)            |
| Government            | 4,713 (10%)            | 3,436 (17%)           | 15,653 (24%)           |
| Mining (all minerals) | 10,578 (23%)           | 1,609 (8%)            | 1,132 (2%)             |
| Trade/Service         | 13,382 (29%)           | 4,650 (23%)           | 21,352 (33%)           |
| Other**               | 5,182 (11%)            | 2,508 (13%)           | 11,836 (18%)           |
| TOTAL                 | <u>46,146</u>          | <u>20,004</u>         | <u>64,489</u>          |
| <u>1977</u>           |                        |                       |                        |
| Agriculture           | 3,658 (2%)             | 2,664 (11%)           | 3,825 (4%)             |
| Construction          | 47,468 (28%)           | 2,884 (12%)           | 11,656 (12%)           |
| Government            | 7,051 (4%)             | 5,209 (21%)           | 23,593 (25%)           |
| Mining (all minerals) | 62,892 (37%)           | 3,940 (16%)           | 6,701 (7%)             |
| Trade/Service         | 32,977 (19%)           | 5,912 (24%)           | 32,170 (34%)           |
| Other**               | 16,903 (10%)           | 4,185 (17%)           | 16,701 (18%)           |
| TOTAL                 | <u>170,949</u>         | <u>24,794</u>         | <u>94,646</u>          |

Source: U.S. Department of Commerce, Bureau of Census and Economic Analysis.

\* Not shown to avoid disclosure of confidential information. Data included in totals.

\*\* Includes utilities, transportation, manufacturing, and proprietorships.



### Revenues Generated by the Oil and Gas Industry

Oil and gas extraction contributes to the economy of the resource area in three ways. First, some of the wages paid directly to employees in the oil and gas industry come from markets outside the resource area; such wages constitute a net flow of dollars into the economy. Second, it is estimated that 2.25 jobs--in medical, education, construction, and retail services--are created in the resource area for every job in the oil and gas industry (Gladstone 1976). Finally, counties receive from the state a share of taxes and royalties derived from oil and gas production. These taxes and royalties are described below.

Severance taxes are assessed by the State of Wyoming on all minerals extracted within the state, whether federal or private. The severance tax rate for oil and gas is 4% of the value of the products extracted; 2% of the tax received is distributed to the state general fund and 2% to the state mineral trust fund. (The mineral trust fund itself is not expended, but income from it goes into the general fund.)

The oil and gas industry pays two types of state ad valorem (property) taxes: approximately 6.25% of the value of oil and gas extracted, as well as tax on the value of property such as company buildings, pumpjacks, and pipelines. The state distributes ad valorem taxes to local governments, which use the revenue as needed. In 1977, the statewide average use was as follows: school districts 69%; county funds for such things as road maintenance and law enforcement 17%; school foundation (equalization fund) 9%; municipal funds for such things as street maintenance and law enforcement 2%; and special district 3% (Thompson and Schutz 1978).

Sales tax of 3% (4% in Campbell County) and use tax of 3% (use tax is charged on the value of property, such as construction supplies, brought to Wyoming from another state) on oil and gas operations are also paid to the state, which returns one-third of the sales tax collected (one-half in Campbell County) and one-sixth of the use tax to local governments.

The oil and gas industry pays royalties and rents to the federal government for their federal leases; 50% of this revenue is returned to the state, which distributes it as follows: municipalities 7.5%, counties 2.25%, state highway work in counties affected by resource development 2.25%, the school foundation program 37.50%, the state highway fund 26.25%, capital outlays for higher education 6.75%, public schools capital construction 4%, and other 13.5%.

### Residential Areas

The development of oil and gas resources in or near residential areas presents special problems, particularly those related to aesthetics and public safety. Residential land quality is affected by the presence of an oil field: dust and objectionable odors drift into residential areas, the noise of internal combustion engines is objectionable, and oil production facilities are eyesores. Safety



hazards include additional traffic (some oversize or carrying crude oil) on residential streets, the potential for explosions and fires, and the presence of heavy machinery and mud pits which endanger children and pets.

The conflict between residential and oil and gas development occurs in one of two ways. First, although 43 CFR 3101.1 prohibits leasing within incorporated cities, towns, and villages, the law cannot control the growth of cities over leases issued years ago. This has occurred in Gillette. Second, leases can be issued and developed beneath existing unincorporated residential areas, such as ranches or subdivisions on the outskirts of cities.

During preparation of an environmental analysis for a proposed oil and gas lease issuance near Gillette, Bureau of Land Management staff solicited comments from the Campbell County Commissioners, the Gillette City Planner, and several homeowners. The consensus was that leasing is acceptable as long as the health, safety, and welfare of the citizens are protected. Only one family recommended that no leasing be allowed. Based on the feeling in Gillette and the provisions of the law, a no-leasing policy is recommended only for the incorporated areas of Buffalo, Clearmont, Dayton, Gillette, Kaycee, Ranchester, and Sheridan. Leasing near or beneath other residential areas should be subject to a special lease stipulation; this stipulation would alert lessees that development activities will be subject to special requirements protecting the residents' health and property.



## IMPACTS OF ALTERNATIVES

### Alternative # 1

Selection of all or any part of alternative #1 would place no-surface-occupancy or no-leasing restrictions on up to 108,000 acres of the resource area currently open to leasing with only standard stipulations. However, as noted below, the impact on oil and gas resource development would be low, except in the Fortification Creek area.

1. Prohibiting surface occupancy in the northern portion of the Ed O. Taylor Big Game Range would provide protection for elk and their habitat by preventing proliferation of trails and destruction of forage. Use of this protective restriction would be consistent with Bureau of Land Management land use decisions for other big game ranges in the resource area and would support the Wyoming Game and Fish Department's management objectives.

Because the northern portion of the game range is up to 2 miles wide, use of the no-surface-occupancy restriction would make some federal oil and gas estate inaccessible by present drilling methods, namely that beneath approximately 1,400 acres. Oil and gas beneath the remainder of the area (2,600 acres) would have to be reached by more costly directional drilling. However, it should be noted that the potential for oil and gas discoveries in this area is considered slight (Babbitts and Gobel, unpublished paper 1978), and demand for leases is correspondingly low.

2. Current land use decisions have placed seasonal restrictions on oil and gas development in elk critical winter and calving range. However, this protection may be inadequate, because use of roads already constructed would occur year-round, for both well maintenance and recreation.

Prohibiting surface occupancy in elk critical habitat would remove approximately 100,000 acres of critical elk winter and calving range from the lands open to oil and gas leasing. The beneficial impact would be to preserve habitat for approximately 800 elk, thus insuring their survival. Secondary beneficial impacts would be to prevent watershed damage due to soil disturbance on the steep terrain characteristic of elk habitat; to eliminate new road construction, tempting to off-road vehicle users; and to prevent deterioration of aquatic habitat by sedimentation.

The significant adverse impact of using this protective condition would be the loss of potential oil and gas production, royalties, and rents. The potential for finding oil and gas in the southern Big Horns (62,000 acres of elk critical winter and calving range) is considered low (Babbitts and Gobel, unpublished paper, 1978), and industry interest in development is correspondingly slight. However, industry interest in developing the Fortification Creek area (39,000 acres of elk critical winter and calving range) is moderate and



probably increasing; the interest is based not only on geology but also on (1) producing wells nearby and (2) oil traces found in dry holes within the Fortification Creek area. Therefore, a no-leasing decision for the elk habitat in Fortification Creek would probably be protested.

3. Use of the protective restriction for eagle roosts would create two zones of protection around each of three known communal eagle roosts in the resource area, and any identified in the future. The first zone, in which no surface occupancy would be allowed at any time, would extend .5 mile from each roost. This would prevent man-made intrusions and human encroachment near the roosts. The second zone would have a seasonal no-surface-disturbance restriction from November 1 to March 30; it would extend an additional .5 mile from each roost. The beneficial result would be to prevent disturbance of bald eagles during the critical winter season. With some seasonal adjustments, exploration for and extraction of oil and gas could occur beneath both zones.

4. By prohibiting surface occupancy in the Outlaw Cave archeological district, and hence prohibiting leasing in some parts of it, the Bureau of Land Management would prevent the accelerated deterioration of a significant assemblage of cultural resources, thus preserving it for future research and education. An adverse impact is exclusion of the Outlaw Cave area from oil and gas exploration and development. However, this area is not considered to possess potential for oil and gas resources (Babbitts and Gobel, unpublished paper, 1978).

5. The most effective way to preserve significant cultural resources and the settings in which they occur is to allow no surface occupancy on sites of National Register quality and to set construction and camouflaging requirements for an appropriate buffer zone around each site. This protection has been provided already for several sites in the resource area through land use planning decisions. Selection of this part of alternative #1 would extend similar protection to all sites listed on or determined eligible for the National Register, including those identified in the future. National Register quality sites presently identified in the resource area (Map I, Appendix), except the Outlaw Cave archeological district, are much less than 1 mile in diameter. Therefore, leasing these sites with no surface occupancy would still allow development and drainage of oil and gas resources beneath them. If National Register eligible sites or districts larger than 1 mile in diameter are identified in the future, the no-surface-occupancy restriction would have to be given careful scrutiny to prevent unnecessary exclusion of oil and gas development.



6. Prohibiting surface occupancy on the recreation and public purpose (R&PP) areas for the cities of Gillette and Sheridan would prevent conflicts in surface use. It would also be consistent with management decisions for other recreation and environmental education areas. There would be no adverse impact to the oil and gas industry since the areas involved are 120 acres and 560 acres, respectively; and oil and gas beneath can be drained from outside the R&PP areas.

7. Deferring oil and gas leasing where there are existing coal leases with approved mining and reclamation plans would prevent surface use conflicts during the life of each coal mine. There would be neither adverse nor beneficial impacts to natural resources resulting from selection of this alternative, and no long-term adverse impacts to the oil and gas industry.

#### Alternative #2 (No Action)

For the reasons discussed in Chapter 1, the no action alternative is considered inviable.

## CHAPTER 3 MITIGATING MEASURES AND RESIDUAL IMPACTS

### MITIGATING MEASURES FOR LEASES

The current Management Framework Plan (MFP) for the Buffalo Resource Area identifies several lease stipulations, which are intended to reduce environmental impacts of oil and gas development activities. During development of this environmental assessment, resource specialists determined that some additional mitigating measures could be selectively applied to oil and gas leases to preclude other environmental impacts. These measures pertain to seasonal restrictions, rehabilitation requirements, or the prevention of multiple use conflicts. Application of any of these mitigating measures as lease stipulations would require amendment of the MFP.

#### Protection of Soil and Water Resources

1. Allow no exploration, drilling, or other development activity in areas of severe erosion hazard (see Map D, Appendix) from March 1 to June 15. This limitation does not apply to maintenance of producing wells. Exception to this limitation in any year may be specifically authorized in writing by the District Engineer, GS, with the concurrence of the District Manager, BLM.

Rationale. Prohibiting surface disturbance in areas of severe erosion hazard from March 1 to June 15 would prevent or reduce the following adverse environmental impacts: unnecessary damage to soils and vegetation; soil erosion and subsequent pollution of surface water and aquatic habitat; and the possibility of reserve pit failure and spillage of toxic materials. A 3-month seasonal restriction on exploration and construction activities would not prevent development of oil and gas and might reduce reclamation costs.

#### Reestablishment of Vegetation

2. Apply the following stipulation to leases where sandy soils occur. (The presence of sandy soil must be determined by a field inspection.)

"During rehabilitation of dry holes, abandoned wells, or unused portions of producing locations, mulching with 2 tons per acre of hay, straw, or excelsior wood fiber and/or soil retention blankets or nettings made of paper, jute, cotton, or biodegradable plastic will be used on all areas of surface disturbance in sandy soil (legal description) of this lease). As an alternative to mulching, a nurse crop of annual cereal (barley or oats) may be used where annual precipitation equals or exceeds 14 inches."

Rationale. Requiring mulch for reclamation of areas with sandy soil would increase the chances of successful revegetation from the initial seeding. The result would be to hasten restoration of vegetative productivity, to prevent soil loss due to wind and water



erosion, and to reduce the chances that costly repeat seedings would be necessary.

3. Where privately owned surface is grazed by livestock, particularly sheep, and where landowner concurrence has been obtained, lease with the following stipulation. (Actual livestock use must be determined by field examination.)

"All dry holes, abandoned wells, or unused portions of locations in (legal description) will be fenced for two growing seasons after reshaping and reseedling is complete. The fence will be of sufficient quality to exclude livestock."

Rationale. Fencing of abandoned and newly seeded locations to prevent livestock grazing for two growing seasons is a requirement for federal surface. (Any other method which effectively excludes grazing is an acceptable alternative.) The purpose of this requirement is to hasten reestablishment of vegetation, thus reducing the time soils are exposed to wind and water and discouraging the growth of the noxious weeds.

Use of this mitigating measure would extend the same beneficial impacts to privately owned surface, if the landowner concurs. The additional expense to the oil companies for fencing would be offset, in many cases, by their not having to reseed to achieve successful revegetation.

#### Protection of Wildlife Habitat

4. Apply the following stipulations to leases in the southern Big Horn Mountains (see Map G, Appendix):

--In canyons containing perennial streams, no drilling or road building will be allowed on slopes steeper than 15%.

--Road and drill pad construction in stands of mountain browse (mountain mahogany, bitterbrush, serviceberry) will be avoided. If there is no possibility of placing a road or drill pad away from these stands of brush, then seedlings of the species disturbed must be planted in a density comparable to that in the adjacent undisturbed stand.

--When exploration is completed and no petroleum is found, or when a field is abandoned, all roads will be recontoured and reseeded with a mixture of grass and forbs (and brush in mountain browse areas). All abandoned roads will be barricaded and made unsuitable for vehicular travel.

Rationale. Use of this mitigating measure would provide three types of protection for wildlife habitat in the southern Big Horns.

First, exploratory drilling and road building would be restricted to 15% slopes or less in the canyons of perennial streams. The important beneficial impact would be to prevent deterioration of aquatic habitat due to sedimentation. The effect of such a restriction on oil and gas development would mean that drilling would be done near ridgetops and on benches, well away from the streams (an existing land use decision) that are also on slopes 15% or less. Therefore, oil companies might have to directional drill their wells. This would increase drilling costs. However, locations on gentle



slopes would require less earthwork, and reclamation costs would be lower, too.

Second, the replacement of browse species (such as mountain mahogany) destroyed during road or drill pad construction would help maintain forage for both elk and mule deer. There would be slight additional reclamation cost for the oil companies.

Finally, barricading roads no longer needed for oil and gas production would prevent vehicular travel. This, in turn, would reduce disturbance of wildlife, allow vegetation to become reestablished, prevent further damage to soils, and discourage uncontrolled recreational use. The cost of constructing barricades would be minimal, since natural materials could be used.

5. Designate suitable buffer zones of no surface disturbance from March 1 to June 30 around active nests of golden eagles, prairie falcons, merlins, Cooper's hawks, ferruginous hawks, Swainson's hawks, red-tailed hawks, great-horned owls, long-eared owls, and burrowing owls. (An active nest is defined as one that has been used at least once during the three previous years.) The size of the buffer zone will be determined on a case-by-case basis by the Bureau of Land Management (BLM) Area Biologist, who will consider topography and raptor prey habitat surrounding the nest site. Buffer zones for active eagle nests and falcon (excluding kestrel) cliff nesting sites will be determined in consultation with the U.S. Fish and Wildlife Service. Nests of other species of special interest to federal and state wildlife agencies would be similarly protected although their presence in the resource area is unlikely; these species are the bald eagle, peregrine falcon, and osprey.

Rationale. The current MFP restricts surface disturbance around active raptor nests for a radius of .5 mile from March 1 to June 30; use of this mitigating measure would make the buffer zone determination for oil and gas leasing consistent with that for coal leasing.

Determining seasonal buffer zones for active raptor nests on a site-specific basis would increase the protection BLM can afford raptors, and at the same time, could benefit oil and gas developers. An arbitrarily determined buffer zone, such as the .5-mile one specified in the current MFP, may be inadequate to prevent line-of-sight contact between a nesting raptor and disturbing human intrusions, particularly in open country. Furthermore, if a nest is readily visible to humans, it is more susceptible to vandalism. In these cases, a larger buffer zone should be specified. On the other hand, in rough or forested terrain, a .5-mile buffer zone may be larger than necessary to prevent disturbance of a nesting raptor. The buffer zone could be reduced and the area available year-round for oil and gas operations correspondingly increased.

The only adverse impact of establishing buffer zones on a site-specific basis would be the additional time required to determine an appropriate buffer zone for each nest site. This could be done either before the lease is issued or at the time specific surface-disturbing activity is proposed.



## Protection of Visual Resources

6. Apply the following stipulation to all leases.

"To preserve aesthetic values, all semipermanent and permanent facilities may require painting or camouflage to blend with the natural surroundings. Paint selection or method of camouflage will be subject to the approval of the District Engineer, GS, and the District Manager, BLM."

Rationale. Use of this mitigating measure would provide the District Manager or his representative the opportunity to specify visually unobtrusive paint colors and/or other camouflage for oil and gas production facilities. The beneficial result would be to reduce the visual impact of man-made intrusions in the landscape. The only adverse impact would be slight, if any, additional cost to the oil companies: facilities are painted in any case; requirements for vegetation screening or other camouflage would be used in limited instances, such as in scenic areas near public roads.

## Prevention of Mineral Resource Conflicts

7. Apply the following stipulation to leases issued on lands wholly or partly covered by a preference right lease application or a federal coal lease for which an approved mining and reclamation plan does not exist (see Map L, Appendix).

"This lease is subject to (coal lease or PRLA number). Stipulations addressed to simultaneous operations will be attached at the time of approval of the application for permit to drill. Plans for oil field development and proposed secondary recovery will be made in cooperation with GS and the coal lease holder."

Rationale. Placing a warning stipulation on oil and gas leases where there are preference right lease applications or existing coal leases without approved mine plans would have no effect on natural resources. It would serve to alert oil companies to the special coordination and expense necessary if extraction of oil or gas and coal occurs simultaneously.

## Prevention of Lands Conflicts

8. Leases within 1 mile of the city limits of incorporated cities, or where residential development is occurring will be subject to the following stipulation. Lands where this stipulation should be applied can be determined from topographic maps and/or field examinations. (Lands within incorporated city limits are excluded by law from leasing.)

"This area is or may be subject to residential development. Oil and gas exploration and development will be subject to specific conditions or stipulations, to be applied at the time an application for permit to drill is approved. These specific stipulations pertain to consultation with residents, noise and dust abatement, and safety measures."

Rationale. Warning oil and gas lessees that there will be special requirements for exploration and production near residences would have no direct effect on natural resources, although indirectly it would serve to protect human lives and property. Use of this mitigating measure would merely mean alerting oil companies to the unusual conditions and extra expense necessary to protect residential areas.



## MITIGATING MEASURES FOR SITE-SPECIFIC SURFACE DISTURBANCE

### Background

Stipulations attached to an oil and gas lease are designed to protect the environment by mitigating impacts over a broad geographic area. The places where drill pads and roads will be needed are not known when the lease is issued. At the time the lessee submits an application for permit to drill a well (APD) or applies for a right-of-way, environmental problems pertaining to that individual case must be dealt with. After a field examination of the proposed drilling location or right-of-way, the Bureau of Land Management (BLM) attaches stipulations to the right-of-way permit or requests that Geological Survey attach them to the APD for protection of the surface resources.

Some of the stipulations used in the past were adequate, but others were not. (The failure of some stipulations has undoubtedly been due to lack of manpower for adequate supervision and enforcement.) During the field seasons of 1978 and 1979, brief inspections were conducted to evaluate the stipulations that had been attached to well locations drilled in the Buffalo Resource Area between mid-1976 and late 1977. Rehabilitation on some locations was satisfactory, but on others was not.

During that period of time, the stipulation "reshape the location by pushing the fill material back to and over the backslope" was extensively used. When operators complied with this stipulation, the results were good. However, at 65% of the sites, operators had not complied with the stipulation.

It was observed that the "respreding of the topsoil" was also not adequate. This was due to either not saving enough topsoil material and/or using the topsoil to reshape the backslope and not evenly redistributing it over the entire disturbed area. Occasionally places on the platform area of the rehabilitated locations had little or no vegetation growing on them. Although this might have been caused by compaction, it was more likely caused by insufficient topsoil depth.

Most locations had water and/or wind erosion taking place. (No locations where mulching was required were checked.) Waterbars that had been constructed were usually not on the contour, were without sufficient drainage to prevent them from washing out, and were usually of an insufficient number. A number of producing wells were observed. It was found that most of them had severe erosion taking place on the fill slopes; some were eroding on the cut slopes. Several of the locations were general sacrifice areas which were not reshaped or fully revegetated outside the area needed to operate the well. Roads



leading to the producing wells, both older wells and newly drilled wells, were generally in need of culverts and drainage relief ditches.

Vegetation on some abandoned locations had been overgrazed by sheep. The overuse tended to retard the establishment of grasses and, in some areas, allowed weeds to dominate the area.

A check on stipulations written for well locations approved for drilling in the past 6 months revealed that requirements for waterbars and other erosion-prevention devices had not been included at all. In some cases, this was because the private surface owner requested that they not be stipulated; in rare instances, the land may have been flat and erosion-prevention devices unnecessary; in other cases, the lack of appropriate stipulations may have been due to oversight.

### List of Mitigating Measures

Because of the inadequacies in present stipulations, or their inconsistent application, adverse environmental impacts are occurring unnecessarily as a result of oil and gas activities. This section describes mitigating measures which would alleviate some adverse impacts.

Based on past success, or lack of it, resource specialists in the Buffalo Resource Area have derived the following mitigating measures for selective attachment as stipulations to geophysical exploration permits, APDs, and rights-of-way. Selection of stipulations must be based on conditions at each specific site. (Those items marked with asterisks are being used currently and could, therefore, be considered part of the proposed action (Chapter 1). However, due to their inconsistent application, noted above, and in order to provide a ready reference for field personnel, they are combined here with new items.) Some mitigating measures are equivalent to standard stipulations published by the BLM Wyoming State Office for use with rights-of-way permits/grants. Numbers of equivalent stipulations are cited below in parentheses.

#### Protection of Soils, Water Resources, and Vegetation

The mitigating measures below are partially drawn from specifications in Surface Operating Standards for Oil and Gas Exploration and Development, a booklet published by the Geological Survey (GS), the Bureau of Land Management (BLM), and the Forest Service.

#### Geophysical Exploration.

1.\* "No blading or other dirtwork will be allowed without written permission from the District Manager, BLM."



2.\* "The operator shall avoid any operations when the ground is muddy and/or wet. District Manager, BLM, may prohibit exploration during wet or heavy snow periods."

3.\* "The operator will reseed all disturbed areas as directed by the District Manager, BLM. Adequate vegetative cover will be established."

Adequate cover will be determined through soil testing, vegetatedensity guides, etc.

4.\* "Rehabilitation of disturbed areas is to be done concurrently with the geophysical operations insofar as possible. Seeding shall be done during the months of September or October. Although chances of failure are much greater with spring seeding, seeding may be done during April or May if approved by the District Manager, BLM."

5.\* "The operator may not remove or damage trees without specific approval from the District Manager, BLM. All merchantable timber shall be purchased by the operator at the total appraised price that is determined by BLM."

6.\* "The operator must notify the District Manager, BLM, of the date rehabilitation operations commence and are completed."

Well Location and Access Road Construction (APDs). It is policy that the removal or disturbance of soil and vegetation will be allowed only for an area large enough for the safe operation or construction of oil and gas facilities.

To help in reducing the amount of disturbed surface, it is also policy that existing roads will be used whenever possible. The operator will coordinate with the surface owner(s) to limit the amount of road construction. The operator will use only those access routes designated on the map attached to the approved exploration/operating plan.

7. "The operator will not push soil material and overburden over sideslopes or into drainages. All soil material disturbed will be placed in an area where it can be retrieved."

8.\* "Prior to construction of the location and access road, slope stakes for cut and fill limits must be placed. The stakes are to be left in place until construction is complete; if they are removed or destroyed, the operator must replace them."

9.\* "A representative from BLM will monitor site construction, including construction of the core trench and dike (see # 14, below)."

10. "If there is snow on the ground when construction begins, the operator will remove it before the soil is disturbed, and pile it downhill from the topsoil stockpile location."

11.\* The operator will remove the top \_\_\_\_\_ inches of soil material from all areas on the location that are to be cut or filled, and stockpile it at the site (approximately \_\_\_\_\_ cubic yards)."

The amount of soil material includes all the A horizon and enough of the B horizon to adequately cover the disturbed area when it is rehabilitated. The depth of the soil removed varies from site to site, as does the volume.

12.\* "The operator will place the reserve pit for any drilling location constructed on a slope of 25% or greater on the side of the location next to the backslope."

This measure would eliminate any chance of the reserve pit rupturing. The steeper topography, 25% and greater, prevents the proper construction of reserve pits when they are on the outside edge of the location.

13. "The operator will build the reserve pit such that a minimum of one-half the total depth at the outside edge is below the original ground surface."

This measure would aid in preventing a pit wall failure or rupture.

14. "For all locations where the soil is sandy or where the slope is between 10% and 25%, the operator will construct a dike with a \_\_\_\_\_ foot top width (10-foot top width is ideal) for the downhill side of the reserve pit. The dike will be constructed with a core trench at least 12 feet wide and 4 feet deep under it. The core trench and dike will be constructed by placing fill material in even continuous layers not more than 8 inches in thickness. Compaction will be by wheeled vehicles only. Track-type equipment is not acceptable for compaction."

This measure would help prevent the rupture of reserve pits.

15. "The reserve pit will be oriented to prevent collection of surface runoff. After the drilling rig is removed, the operator will construct a trench on the uphill side of the reserve pit to divert surface drainage around it. The trench will be left intact until the pit is closed."



16. "Reserve pits constructed in porous material close to perennial streams or public drinking water sources will be lined with plastic before they are filled with water."

This measure would help prevent leakage of the contents and possible surface water contamination.

17. "The operator will construct the location backslope (cut slope) no steeper than \_\_\_\_; until production is obtained, the foreslope may be at the slope of the natural fall of earth (approximately 65%), after which the foreslope (fill slope) is to be reshaped to a \_\_\_\_ slope or flatter."

The acceptable steepness of the backslope and foreslope varies from site to site. The chart given below is to be used as a guide, but may be adjusted due to soil type or irregularity of the topography.

| Existing Slope | Backslope            | Foreslope |
|----------------|----------------------|-----------|
| up to 5%       | 4:1 (25%) or flatter | 4:1 (25%) |
| 6% to 15%      | 3:1 (33%)            | 3:1 (33%) |
| 16% to 20%     | 3:1 (33%)            | 3:1 (33%) |
| 21% to 25%     | 2:1 (50%)            | 2:1 (50%) |
| 26% to 40%     | 1.5:1 (65%)          | 2:1 (50%) |

18. "Except on level terrain or where the private landowner requests otherwise, the operator will construct waterbars on both dry-holes and producing locations. Construct waterbars at least 1.5 feet deep, on the contour, with approximately 2 feet of drop per 100 feet of waterbar to ensure drainage, and so water drains onto established vegetation. All waterbars are to be constructed with the berm on the downhill side to prevent the soft material from silting the trench full."

A guide for waterbar spacing is as follows (see Figures 1-11 through 1-14). Unstable soils may require a closer spacing, whereas the spacing on stable soils or rock outcrop may be wider.

25% slope or flatter: at the top and bottom of the cut slope; at the top of the fill slope.

25% to 33% slope: at the top, middle, and bottom of the cut slope; at the top and middle of the fill slope.

more than 33% slope: at the top, middle, and bottom of the cut slope or at the top of the cut slope and spaced 25 feet apart from the top of the cut slope to the bottom of the cut slope, whichever is at the closer interval; at the top, middle, and bottom of the fill slope or at the top of the fill slope and spaced 25 feet apart from the top of the fill slope to the lower edge of the disturbed area, whichever is at the closer interval.

Waterbars placed on the contour every 40 feet on a 400-foot, 30%, slope would reduce the expected erosion by 66%; waterbars placed on the contour every 20 feet on the same site would reduce the expected erosion by 80%.

19. "On well locations having a backslope (cut slope) with a 50% slope or steeper, which is 15 feet or more in length, the operator will build a terrace 12 to 14 feet wide (sidehill construction) or 3 to 4 feet wide (downhill construction). The terrace will be inclined toward the backslope and on the contour, midway between the top and bottom of the backslope."

Occasionally, the construction people fail to reshape the backslope and to adequately waterbar it because of the steepness. The terrace would be a built-in aid to control erosion.

20. "The operator will build an impermeable dike or berm around tanks, separators, and wellheads to contain tank contents. The operator will also construct and maintain a drainage ditch, berm, or waterbar along the outer edge of each producing well location to control runoff."

This measure would contain contaminants dumped or spilled on the location and prevent them from damaging vegetation or surface water. It would also aid in preventing erosion on the fill slope of the location.

21. "For an oil well drilled within .5 mile of existing water wells, the operator will cement the surface casing in place to a depth below that of all water wells within .5 mile."

This measure would prevent possible contamination of groundwater supplies. (See also # 81, below.)

22. "Temporary roads will be single-lane and flat-bladed, unless cuts greater than 2 or 3 feet are necessary, in which case the road must be crowned and ditched. All roads must be maintained by the operator."

23. "The operator will avoid constructing new roads in or through drainage bottoms, whenever possible. Low water crossings will be used for temporary roads crossing dry drainages when feasible (Figure 3-1). (If the road is to be retained, for example, installation of a culvert may be preferable.) Feasibility of proposed crossing of flowing streams will be analyzed by the Division of Operations, BLM. Engineering designs will be submitted by the oil company with the APD."

This measure would be used on a case-by-case basis and would aid in the prevention of contamination of the streams with silt. In an



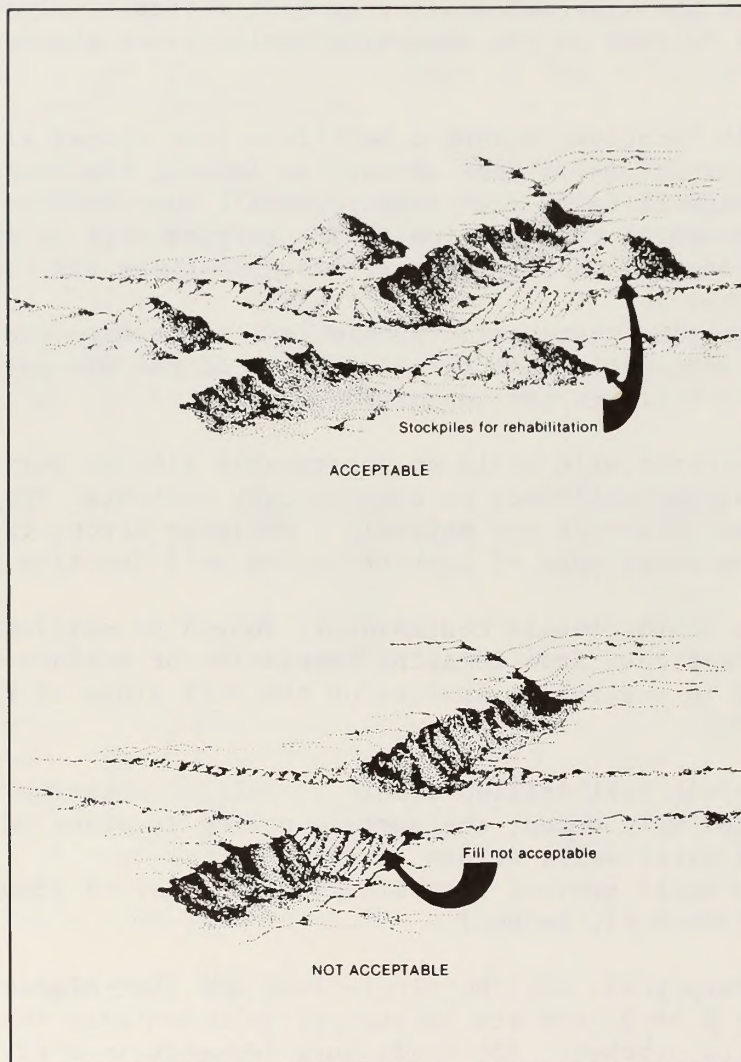


Figure 3 - 1  
Typical Dry Creek Drainage Crossing

APD submission, the oil companies generally do not address potential problems.

24. The specifications for upgrading access roads to producing wells (see below) will be applied to temporary roads in unstable areas if those roads are to be used during the spring thaw.

25.\* "The operator will cover and enclose the burn pit with small mesh wire, to prevent trash from being blown off site, and to prevent wildfires. After the burn pit is no longer in use, the operator will cover it with a minimum of 2 feet of earth."

26.\* "The operator will fence the reserve pit on all four sides at the time the rig is removed."

If the Well is a Dry Hole or Abandoned.

27. "Immediately upon abandonment, the operator will seal the wells and remove flowlines, storage tanks, and other equipment."

28. "Complete dewatering and rehabilitation of the reserve pit shall be accomplished by the operator within \_\_\_\_\_ calendar days from the date the pit is no longer needed for drilling, abandonment, or completion operations.

" Prior to backfilling and recontouring the reserve pit areas, all liquid material shall be disposed of by one of the following methods:

- a. Evaporation.
- b. Removal and transportation of liquids to an evaporation pond approved by GS.
- c. Subsurface disposal at a disposal well, provided authorization for the subsurface discharge has been obtained from the Wyoming Department of Environmental Quality (DEQ) (Rules and Regulations, Chapter IX) and the disposal operation is approved by GS. If approved by GS, suitable fluids may be used in subsequent drilling of other wells in the vicinity.

- d. Disposal by surface discharge, provided the necessary written authorization has been obtained from the Wyoming DEQ with concurrence by GS and BLM. The discharge would be by siphoning or pumping the water out of the pit and onto established vegetation. Each discharge would require monitoring to ensure that no contaminants are taken out of the pit and that the discharge does not cause erosion.

"The operator should contact the BLM Casper District Manager for procedures to be followed to obtain authorization for pit dewatering."



Note: Number of days allowed for dewatering will be determined for each individual situation. The maximum time period allowed will be 8 months.

29.\* "During reclamation of the site, the operator will push fill material back into the cuts and up over the backslope to approximate the original topography. No depressions will be left that will trap water or form ponds."

This measure should be attached to all APDs for locations requiring a cut of more than 3 feet to level the platform.

30. "After the location has been reshaped and prior to redistributing the topsoil, the operator will rip or scarify the drilling platform on the contour, to a depth of at least 12 inches. The ripped places are to be no farther than 24 inches apart."

Ripping breaks up compaction and allows rainfall or snowmelt to penetrate the soil."

31. "The operator will distribute the topsoil evenly over the entire location and prepare the seedbed by disking on the contour to a depth of 4 to 6 inches."

Prompt redistribution (preferably within 9 months of removal) is helpful for revegetation of disturbed areas, since native seed and rootstock can survive only short periods of stockpiling.

32. "The operator will drill seed on the contour to a depth of .5 inch, followed by cultipaction to compact the seedbed, preventing soil and seed losses. To maintain quality and purity, certified seed with a minimum germination rate of 80% and a minimum purity of 90% will be used. The following mixture will be used: \_\_\_\_\_

Slopes too steep for machinery may be hand broadcast and raked with twice the specified amount of seed.

"If forested areas are disturbed, containerized tree seedlings will be planted. If stands of mountain mahogany or other elk/deer forage are disturbed, the same species will be replanted in a density equivalent to that in undisturbed stands."

Seed mixtures and rates will be determined on the basis of landowner preference and/or existing native vegetation on adjacent areas. Grass seed mixtures appropriate for different soil and precipitation conditions are shown on Map N, Appendix. Seed mixtures should contain forb and shrub species.

33.\* "The operator will complete fall seeding after September 1st and prior to ground frost. To be effective, complete spring seeding after the frost has left the ground and prior to May 15th. All



rehabilitation work, including seeding, will be completed by \_\_\_\_\_  
\_\_\_\_\_."

34a. "The operator will mulch all areas of disturbance (roads, flow lines, or locations) on slopes greater than 25% or in sandy soil with hay, straw, or excelsior wood fiber and/or soil retention blankets or nettings made of paper, jute, cotton, or biodegradable plastic. All manufactured or processed materials are to be installed according to manufacturer's specifications. Hay or straw is to be applied at the rate of approximately 2 tons per acre. The mulch is to be anchored 2 to 3 inches deep with a straight colter with 6- to 12-inch spacing. A disk may be used if the mulch is left sufficiently exposed to afford protection. Mulch should be anchored perpendicular to the prevailing wind on flat sites and on the contour on slopes. Mulch is to be applied after the waterbars are constructed and reseeding completed."

According to the Soil Conservation Service (Universal Soil Loss Equation and soil loss tolerance values) mulching disturbed areas with 2 tons per acre of straw or native hay is equal to 80-100% vegetative cover. As an example, the Shingle soil in Table 2-7 will erode approximately 68 tons per acre per year on a 30% slope, 400 feet in length. Mulching at 2 tons per acre will reduce the erosion to only 3 or 4 tons per acre. With waterbar placement every 20 feet, in addition to mulching, the expected erosion would be less than 1 ton per acre, well within the tolerance level. The same results in erosion reduction can be expected on all of the soil types with waterbar placement and mulching. In many cases, usually on slopes less than 20%, depending on soil type, waterbar placement every 20 to 40 feet on long slopes will be sufficient to keep erosion to the tolerance level.

34b. "The operator will rehabilitate sandy sites in areas of at least 14 inches of precipitation using a preparatory cereal nurse crop as follows. The area will be leveled and smoothed, eliminating uneven places and sharp banks in order to permit the use of seeding equipment and cultipackers and to minimize wind erosion. A cereal nurse crop of barley, oats, or sorghum will be seeded in 12-inch rows (not more than 20-inch rows) at a rate of 20 to 40 pounds per acre. A cultipacker will be used to firm the soil. A fence will be constructed of sufficient quality to prevent livestock grazing in the rehabilitated area. To minimize volunteering and competition, the nurse crop will not be allowed to set seed. Therefore, the nurse crop will be mowed prior to seed set in the summer or fall, depending on the time of year it was first seeded. That fall or the following spring, the prescribed perennial seed mixture will be seeded into the nurse crop



stubble. The rehabilitated area will remain fenced until the prescribed seed mixture has become established (at least two full growing seasons)."

35. "For locations on northeast, north, northwest, west, and southwest slopes, the operator will erect snow fences perpendicular to the prevailing wind and of a sufficient length and height to drift snow onto rehabilitated locations. Snow fences will be placed after reshaping, erosion-control structure construction, and reseeding are completed. The fences will be left in place until vegetation has been reestablished for two growing seasons."

Fencing will increase the moisture available to seedlings and increase the chances of successful revegetation (U.S. Department of Interior, Geological Survey 1979, p. BIV-6).

36. "Following reseeding and mulching, the operator will fence abandoned well sites in areas of heavy livestock use for two growing seasons to prevent grazing."

37. "Disturbed areas that have been reseeded shall be entirely fenced by the operator whenever they are located within .25 mile of livestock water."

38. "The operator will mow all weeds between June 1 and June 15 the first year after vegetation is established. An alternative is to control weeds by chemical means until they are exterminated. All herbicides are to be approved for use by the BLM and be applied by a certified applicator."

39. "BLM will not release the performance bond until the area has been successfully revegetated (evaluation will be made after the third growing season) and has met all other reclamation goals."

40. "The operator will reshape abandoned access roads by pushing the fill material back into the cuts. On roads to be permanently closed, waterbars are to be constructed near the contour across the shaped road, \_\_\_\_\_ feet apart."

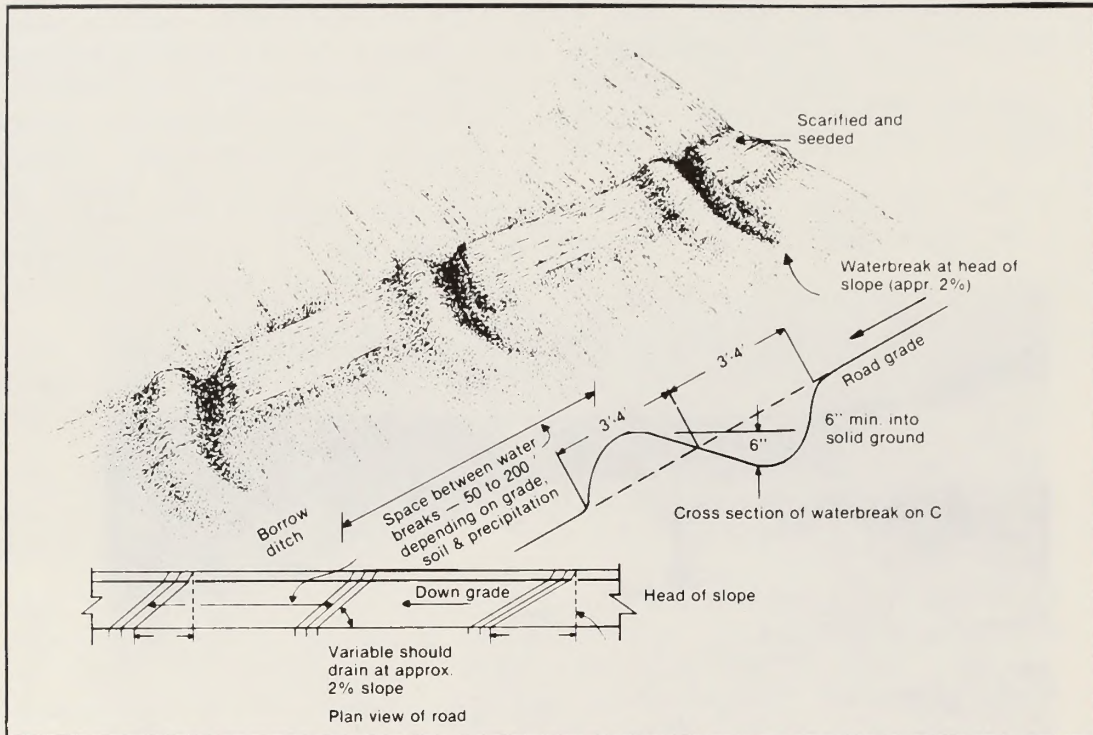
As a guide in determining the distance between waterbars, the following chart can be used (see Figure 3-2):

0-2% grade--200-foot interval.  
2-4% grade--100-foot interval.  
4-5% grade--75-foot interval.  
5-15% grade--50-foot interval.  
15%+ grade--25-foot interval.



Abandoned location: No provision was made to protect the sandy soil from wind erosion. Revegetation has not been successful.





**Figure 3 - 2**  
**Waterbreak Construction**  
 (For access roads and disturbed slopes that will be  
 closed to traffic after operator use)

If it is anticipated the reshaped access road will be used by ranchers, the water diversions can be "thank-you-mams," constructed as illustrated in Figure 3-3. The spacing of the "thank-you-mams" would be the same as for waterbars.

41. "Abandoned roads will be ripped, the topsoil redistributed and disked, seed mixtures and mulch applied, fences constructed, and weeds mowed as described above for abandoned locations."

If the Well is a Producer.

42. "All areas not required for production will be reclaimed by the operator as described above. This includes fencing requirements in areas of heavy livestock use."

43. "The operator will sign and plant to vegetation prescribed by BLM soil material suitable for plant growth that will be stockpiled for 10 months or longer."

44. "All vehicle travel will be confined to the access road and drill pad, as specified in the APD."

45. "Only one permanent road will be allowed to serve the lease area with one permanent road to each well. The operator will upgrade the access road for year-round use: it will be crowned, ditched, and maintained, and drainage ditches, relief culverts, and culverts will be installed as shown in Figures 3-4 and 3-5. Outlet ends of the culverts will be protected with sediment basins, as shown in Figure 3-6, or surfacing may be required."

46. "The operator will control, by mechanical or approved chemical means, all noxious weed invasions along the shoulders and ditches of access roads."

47. "Reseeding and mulching of disturbed soil at stream crossings or in drainage canals is required of the operator."

48. "If production water meets DEQ requirements and is permitted for surface discharge, if BLM determines that it would be of beneficial use for livestock, and if GS concurs, the water will be transported via pipe or open ditch (concrete or rock lined) to the place it is impounded, enters live water, or enters a drainage. If the water is discharged into a drainage, conditions of slope, soil, and rate of flow must be such to prevent erosion."



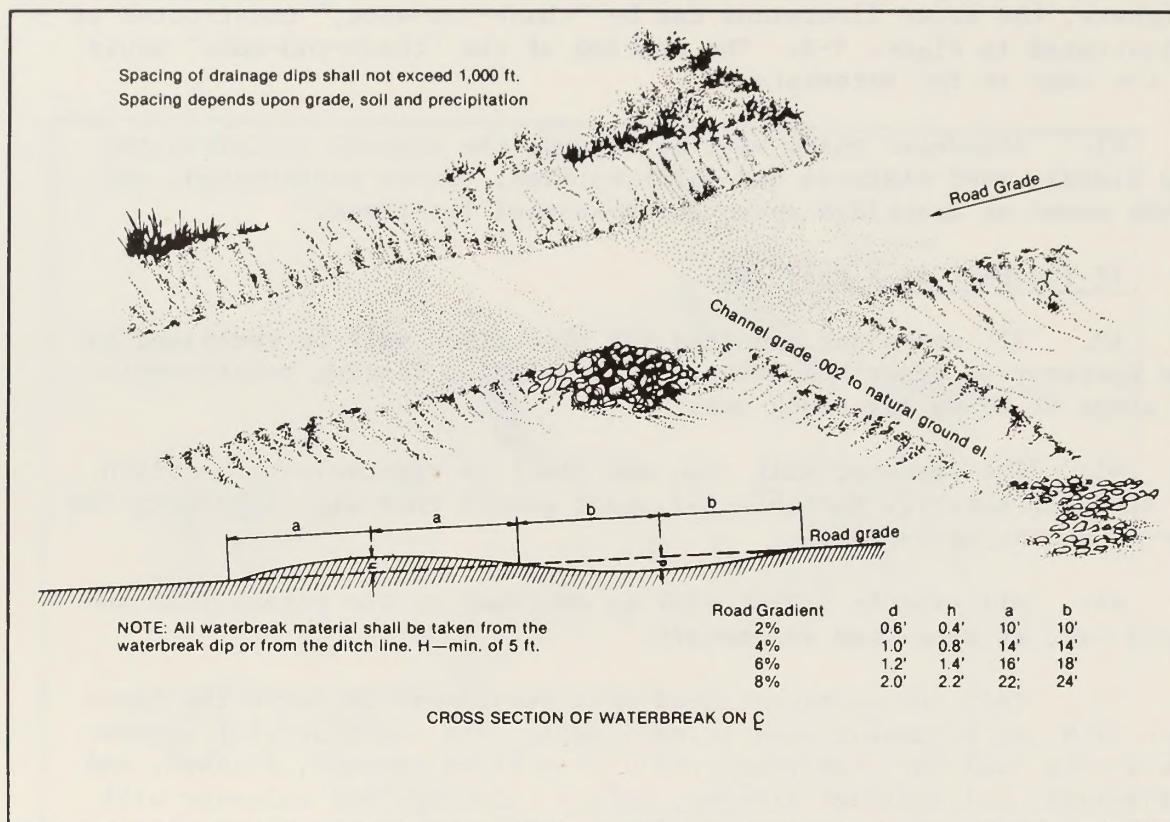


Figure 3 - 3  
"Thank-U-Mam" for Slight to Moderate Slope for Access Roads

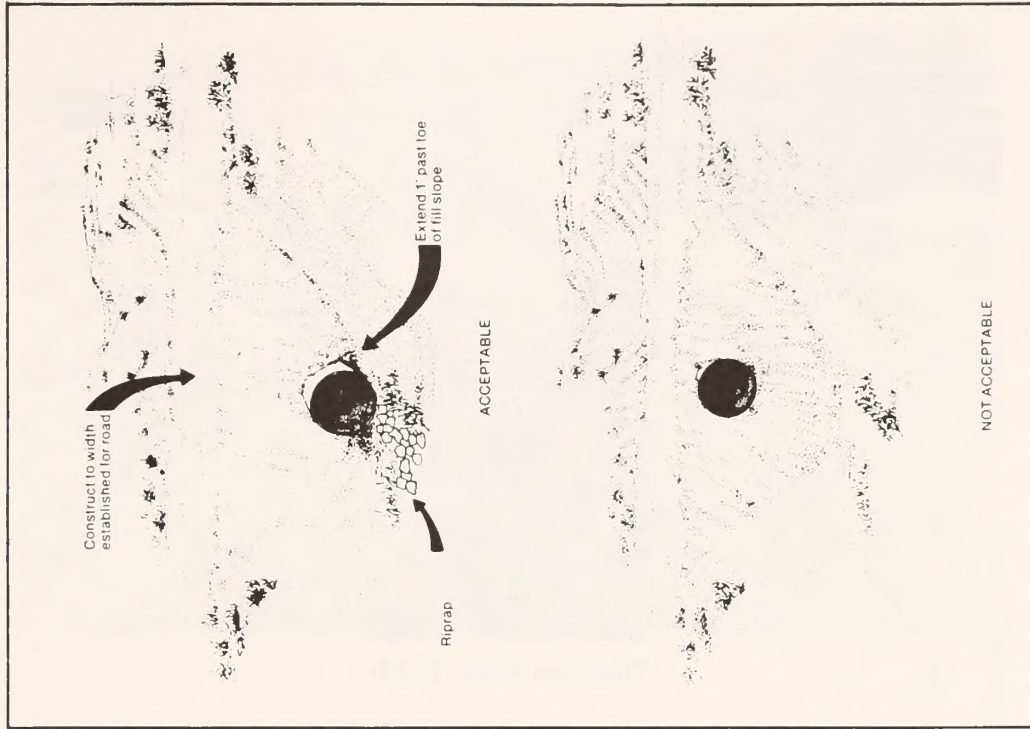
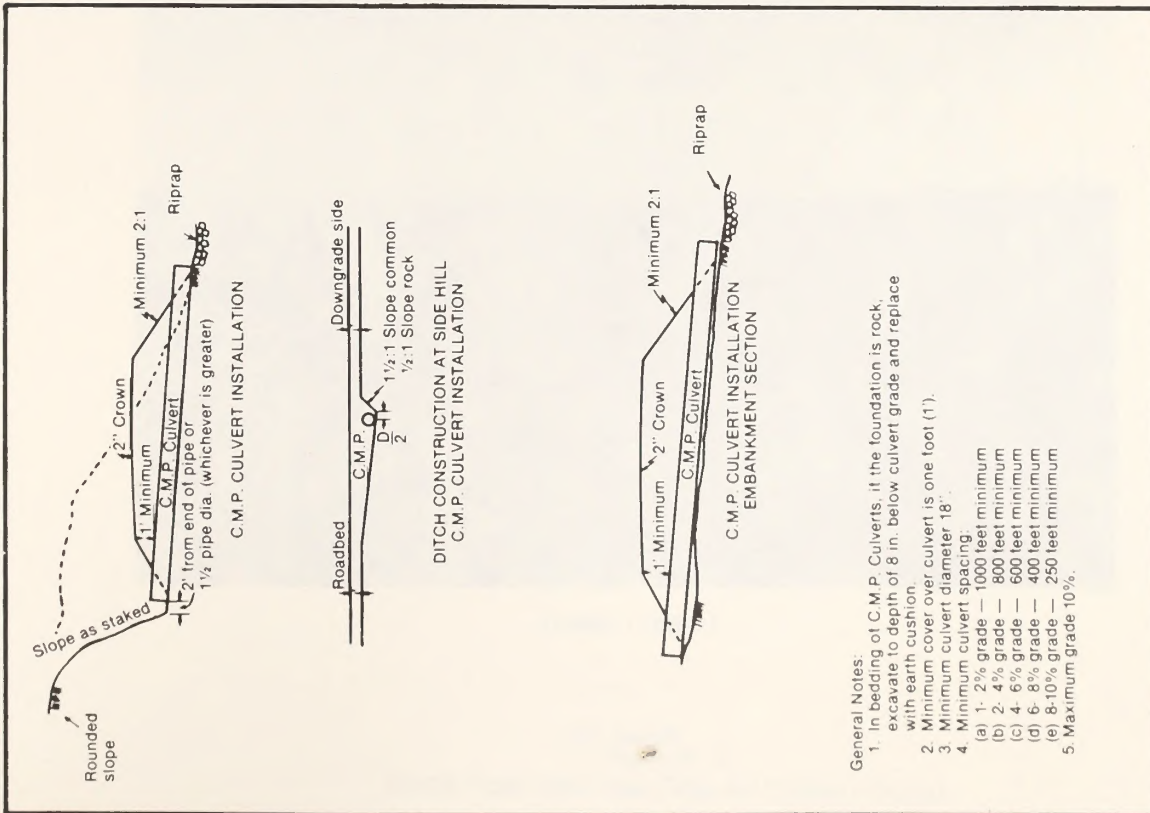


Figure 3 - 4  
Culvert Construction and Installation



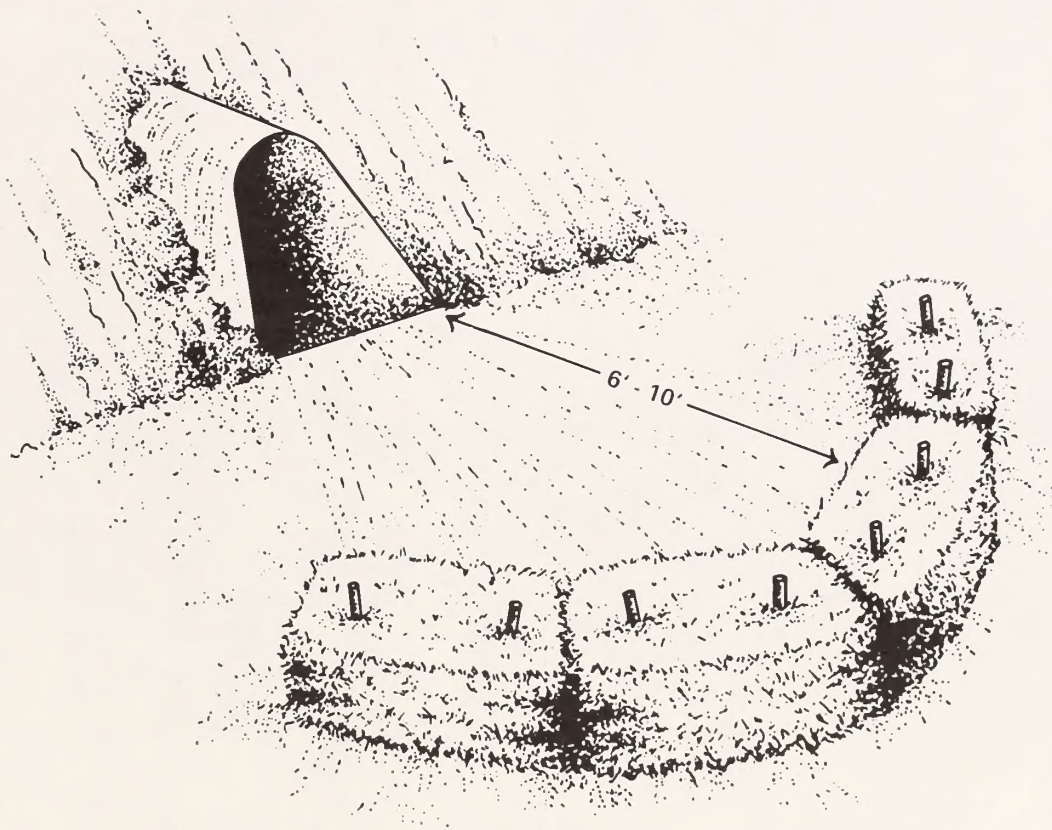


Drainage Relief Ditch



Relief Culvert

Figure 3-5



Key the bales into the ground between 4 and 6 inches to prevent runoff from eroding under them and to anchor them. Steel posts or pieces of rebar are to be driven through the bales as illustrated to further anchor the bales.

Figure 3 - 6  
Straw Bale Sediment Trap At Culvert Outlet



#### Rights-of-Way.

49. \*(IC) "The grantee shall survey and clearly flag the exterior limits of the right-of-way. All activities directly or indirectly associated with the construction or maintenance of this facility must be conducted within the limits of the right-of-way. If the grantee plans to install right-of-way or line markers, the number, size, height, type, and color of these markers must be approved by the District Manager, BLM."

50. \*(IV A) "The grantee will effect a minimum of vegetative or soil disturbance consistent with practical construction operations and will smooth all disturbed areas to conform as nearly as practical with the adjacent terrain, provide adequate water drainage for any roads constructed to minimize erosion, maintain any service roads in good condition for vehicular travel, and permit the free use of any such service roads by employees of the federal government or their authorized agents. The grantee will correct any deficiencies as determined to be necessary by the District Manager, BLM."

51. \*(IX K) "Proper precaution will be taken at all times to prevent and suppress fires. The grantee will be held responsible for suppression costs for any fires on public lands caused through negligence of his employees, contractors, or subcontractors. No debris burning will be allowed without specific permission from the District Manager, BLM."

52. "Construction standards to be followed by the grantee for underground pipelines are as follows:

a. No cuts or fills greater than 4 feet will be allowed.

b. (V C) Clearing of the right-of-way prior to actual pipeline construction shall be restricted to 15 feet either side of centerline. Brush beaters shall be used when possible. If it is necessary to remove soil during right-of-way clearing, graders shall be used, because the depth of cut can be better controlled. Depth of soil removed or relocated during the clearing operation on normal slopes shall be less than 4 inches. This soil will be replaced on the disturbed area prior to reseeding operations.

c. (V D,F) No drainages will be blocked by fill material.

d. (IX) All disturbed areas are to be reshaped. The backfilled ditch is to be compacted so it will not be necessary to leave a berm over the ditchline to compensate for settling. Waterbars will be constructed on all slopes. Revegetation and mulching are required."

Serious consideration shall be given to the use of a tractor-mounted auger backfiller. This type of equipment minimizes damage to the pipe and efficiently fills the trench by allowing the dirt to flow under and around the pipe, eliminating voids in the backfill. The total area disturbed is less than that resulting from conventional operations.

See #40, #32, #33, #34a, and #34b for waterbar and revegetation requirements.

53. (XC) "The operator shall not use pipeline routes for roads without approval of the District Manager, BLM."

### Protection of Wildlife

#### Geophysical Exploration.

54. "No seismic exploration will be permitted in critical elk winter range from December 1 to April 30 or in elk calving areas from May 1 to June 30."

55. "No seismic exploration will be permitted within 1.5 miles of a sage grouse strutting ground from March 1 to June 1 or within .5 mile of a sharp-tailed grouse dancing ground from April 1 to June 1."

56. "No seismic exploration will be permitted within .5 mile of raptor nests from March 1 to June 30 or within 1 mile of bald eagle roosts from November 1 to April 30."

APDs. Any of the following measures can be used to supplement seasonal or occupancy restrictions placed on a lease (see Chapter 1, Proposed Action).

57. In order to ensure that black-footed ferrets are not harmed by oil and gas exploration activities, the BLM Resource Area Biologist will make a site inspection before an APD in a prairie dog town is approved. It is recommended that no surface disturbance be allowed within .5 mile of towns 30 acres or larger (or groups of towns 99 acres or larger).

58. "The operator will flag all reserve pits in such a way as to discourage waterfowl from landing in them."

Rights-of-Way. The following measures can be stipulated, as appropriate, for power line rights-of-way.



59.\* (II C) "The grantee shall construct, operate, and maintain the line in compliance with the following statutes: Bald Eagle Protection Act of 1940, as amended; Endangered Species Act of 1973; and Migratory Bird Treaty Act of 1918, as amended. Construction standards include the following.

a.\* Transformers shall be rendered safe to raptors by covering transformer risers and jumpers and by installation of guards over the transformer high voltage bushing terminals.

b.\* Wooden or nonconducting crossarm braces will be used on all poles with crossarms.

c.\* On all three-phase tangent structures, there will be a vertical separation of at least 38 inches between the center phase and the other two phases. Three-phase dead-end structures may be constructed with less than 38 inches vertically between the center phase and the other two phases if the center phase conductor is dead-ended at least 38 inches horizontally from the structure. The conductor configurations in any case will be such that the center phase will be mounted in the pole position.

d.\* The pole ground wire will not extend above the neutral unless it is covered or double gapped with a total of 8 inches of clear wood."

60.\* "BLM reserves the right to require modification or additions to structures placed on the right-of-way if found to be necessary to insure the safety of wildlife, including raptors. Such modifications will be made without liability or expense to the United States."

#### Protection of Cultural Resources

##### Geophysical Exploration, APDs, Rights-of-Way.

61.\* (VIII D,E,F) (Cultural Resources Stipulation 1.) "The lessee will not disturb the surface of the lease until a cultural resource investigation has been conducted by BLM or a professional acceptable to BLM for the specific area on which surfacedisturbing activity is planned. The results of this investigation will be submitted to the BLM District Manager and BLM will provide stipulations for avoidance or salvage of any significant cultural resources. The cost of all investigations and salvage will be borne by the lessee."

62.\* (IB) (Cultural Resource Stipulation 3.) "If any cultural values are observed during operation on this lease/permit/right-of-way, they will be left intact and the BLM District Manager

notified. The District Manager will conduct an evaluation of the cultural values to establish suitable mitigation or salvage."

In the event that the inventory conducted (#61, above) indicates that cultural resource values may be present, the following condition is attached to the permit authorizing surface disturbance.

63.\* (VIII G) (Cultural Resource Stipulation 2.) "The cultural resource investigation on this lease/permit/right-of-way indicated that buried cultural values may be present. However, surface condition of vegetation, snow, or alluvium prevented an adequate evaluation of these cultural values. To protect and evaluate these values, the permittee/lessee/grantee will engage a professional acceptable to BLM to observe surface disturbance through specific area as given, Section \_\_\_\_\_, Township \_\_\_\_\_ North, Range \_\_\_\_\_ West, and to submit a report to the BLM District Manager within 30 days of completion of the project. If significant values are observed, they will be left intact and the BLM District Manager notified to conduct an evaluation to establish suitable salvage."

If a cultural resource site is discovered in an area where any surface disturbance is proposed, the preferred mitigating measure is to relocate the surface disturbance. This in no way slows the oil and gas industry, provided the shift of drilling location does not pose a problem of unorthodox siting. Even a hearing for approval of an unorthodox location may be more cost-effective than a stipulation that requires expensive and delaying excavation procedures. If faced with a choice of moving the location for a ground-disturbing activity or excavating an impacted site, the choice should be in favor of leaving the resources intact. If avoidance is not possible, site-specific stipulations will be drawn up consisting of excavation requirements, the extent of which will depend on the cultural resource impacted. These special stipulations will be assigned after field examination of the project area.

If the cultural resource site is eligible for National Register listing, final approval to proceed with an undertaking will not be granted until consultation with the Wyoming State Historic Preservation Officer (SHPO) has taken place. If BLM and SHPO agree that there will be no effect to a National Register site, the project may proceed with the BLM retaining documentation of the effect determination and consultation proceedings.

In cases when an effect is determined, additional review is required by the Advisory Council on Historic Preservation to satisfy Section 106 of the National Historic Preservation Act of 1966.



Two suggestions to mitigate the impact to cultural resources by vandalism and unauthorized collecting are as follows: (1) public education about the value of these resources in situ and the fines for violators of the law (emphasized by diligent prosecution of offenders), and (2) prompt closure and rehabilitation of access roads which are no longer needed.

#### Protection of Visual Resources

##### APDs.

64. At the presite inspection, the operator and the BLM representative will consider the following items before deciding whether the location should be on a ridge or on the sidehill:

-- whether the visual impacts of a ridgetop location would be greater than those caused by cut and fill on the sidehill;

--whether the reduction of visual contrast outweighs the difficulty of rehabilitating the location, the loss of fill material, and increase in the sedimentation, etc.; and

--whether the drilling rig and production facilities can be placed away from the edge of a ridgetop location, so that they are screened from public viewpoints.

65. To the extent possible, roads should follow natural contours. Where steep slopes would require extensive cuts and fills, roads should follow ridgelines.

66. "In visual resource management Class II areas, the operator will place production facilities underground if they will be in place more than 6 months, or obtain the assistance of the BLM Recreation Planner for determining production facility locations and/or methods of camouflage."

67. "All semipermanent and permanent facilities located above ground will be painted or camouflaged by the operator to blend with the natural surroundings. The paint selection or method of camouflage will be subject to approval of the GS and BLM. When feasible, natural vegetation and topographic features will be used to screen developments. Exceptions to this color requirement may be granted by BLM for holding or storage tanks that must be black or silver for heat absorption or reflection purposes. Moving parts of machinery that must be painted bright colors for safety purposes shall not be visible for more than .25 mile."

### Rights-of-Way.

68. Power lines and pipelines will be placed in corridors where possible. New construction of overhead power lines should be allowed in rare cases only. Underground power lines should be encouraged. Pipelines and electrical lines should be installed alongside roads wherever possible.

### Protection of Other Mineral Resources

APDs. Due to the number of overlapping coal and oil and gas leases which are in existence, the following three stipulations should be attached to the APD for well locations which are in the area of an approved coal mine plan. (These stipulations are being used by GS.)

69. "In event this well is a producer, prior to the time this well is to be shut-in for the purpose of removing surface minable coal from the well site, the operator will be required to submit a comprehensive plan of operations for removing the surface casing, etc. Such a plan will have to be concurred in by the coal lessee. This plan should be developed in consultation with the Northern Rocky Mountain Area Oil and Gas and Mining Supervisors, as necessary."

70. "In the event the well is to be abandoned, the (Newcastle/Casper) GS District Office must be notified at least 24 hours in advance of setting the surface cement plugs so they may witness same as required by present instructions."

71. "The surface casing shall be not less than \_\_\_\_\_ feet of \_\_\_\_\_-inch-\_\_\_\_\_ -pound casing cemented to the surface."

Due to the potential for a mineral trespass by the oil or gas company to obtain materials for surfacing roads, the following statement should be attached to all APDs that do not clearly state anticipated materials sources.

72. "A sales contract for scoria and/or sand and gravel is required prior to the removal of these materials from an area of federally owned minerals."



## Protection of Ranching Operations

### Geophysical Exploration, APDs, and Rights-of-Way.

73. (VII B,D) "Range improvements, such as fencing or reservoirs, will not be disturbed by the operator, or where disturbance is necessary, they will be left in the original or better condition as determined by the District Manager, BLM, or the surface owner."

74. (VII A) "Before cutting through any fence on public or private land, the operator or grantee will brace the fence firmly on both sides of the cut, and after completion of construction will (1) install a gate and/or cattle guard in the fence, or (2) replace a standard type fence across the right-of-way, as directed by the District Manager, BLM, or the surface owner."

75. "Bond for surface rehabilitation will not be released until the District Manager, BLM, or the surface owner expresses satisfaction in writing."

### APDs Only.

76. Routing of access roads must be determined in cooperation with the private surface owner, if any.

77. "Fencing will be installed and maintained by the operator to prevent livestock access to skim ponds and mud pits."

78. "Drilling or construction will not be done in lambing or calving pastures during lambing or calving season, unless authorized by the livestock operator."

### Rights-of-Way Only.

79. All pipelines, temporary or permanent, will be buried underground to prevent hazardous conditions to livestock.

## Protection of Residential Areas

Selected mitigating measures from the following list may be stipulated for locations in the vicinity of city subdivisions or ranch dwellings.

80. "Prior to drilling exploratory wells, the lessee/operator will present a development plan showing well locations, tank batteries, and flowlines to the inhabitants of any subdivision or ranchhouse within \_\_\_\_\_ mile of the proposed well for their comment."

81. "In order to minimize the possibility of subsurface water supply contamination, casing must be set to a depth of \_\_\_\_\_ feet and cemented to the surface. For wells drilled within city subdivisions, the city engineer must approve the depth of the casing."

82. "All speed limits on subdivision roads are to be the same as in residential areas, if not specifically addressed by statute. The speed on all unsurfaced or gravel roads and trails should be limited to \_\_\_\_\_ miles per hour, if the roads pass within \_\_\_\_\_ mile of a dwelling; this restriction is applicable only to the portion of the road or trail that is within \_\_\_\_\_ mile of a dwelling."

83. "The operator will use dust abatement measures on all access roads passing within \_\_\_\_\_ feet of any subdivision or ranch dwelling, if traffic from the exploration and development activities produces enough dust to be visible from the dwelling. Dust from any drilling pad within \_\_\_\_\_ feet of a residence will be controlled by watering. Topsoil stockpiles will be covered with mulch, netting, or canvas to reduce dust and soil loss."

84. "Any subdivision roads used in exploration activities will be returned by the operator to a condition acceptable to the inhabitants. Any subdivision road used for development and production activities will be maintained to a standard acceptable to the inhabitants. New access roads will be located as far as reasonably possible from existing, occupied dwellings."

85. "The operator will equip the engines powering a drilling rig within \_\_\_\_\_ mile of a dwelling with mufflers that prevent noise levels exceeding 86 db when measured 50 feet away from the source. Exhaust pipes will be directed away from dwellings within \_\_\_\_\_ mile."

86. "The operator will erect a fence, 6 feet high, with not larger than 4-inch mesh around the entire drilling location and reserve pit during drilling. The fence must remain until the drilling equipment is taken away from the area and the reserve pit is closed, if the location is nearer than \_\_\_\_\_ mile to a dwelling. If the well is a producer, the facilities must be fenced for the life of the well."



87. "Trash will be confined in a covered container and removed by the operator to an approved land fill periodically. No trash will be buried at the well site."

88. "The operator will remove the contents of any reserve pit within \_\_\_\_\_ mile of a dwelling to an approved disposal area within 30 days after drilling is complete, and all excavations will be closed."

89. "The operator will not place storage tank batteries or heater-treaters within \_\_\_\_\_ feet of any dwelling unless they are placed in basement type installations."

90. "All pumps and production units in subdivisions will be powered by electric motors and have a noise level no higher than 86 db when measured 50 feet from the source. Pumps and production units within \_\_\_\_\_ mile of ranch dwellings must be similarly muffled and the exhaust pipes directed away from the dwellings."

91. "The operator will keep well sites weed free and vegetate them in a manner compatible with the surrounding area."

92. "Paint colors and structural camouflage, and/or landscaping may be specified for facilities and structures used in conjunction with the exploration and development activities if they remain longer than 90 days."

93. "No burning will be allowed."

TABLE 3-1  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

| RESOURCE VALUE                     | IMPACT                                                                                                                                                | PHASE                             | MITIGATING MEASURE NO.                  | CONDITION WHEN USED | EFFECTIVENESS/FEASIBILITY                                                                | RESIDUAL IMPACT                                                                                                                |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|-----------------------------------------|---------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Air Quality                        | Hydrogen sulfide odor (Cellar's Ranch Oil Field, northwest of Kaycee; ARGO Field west of Rozet                                                        | Production                        | --                                      | --                  | --                                                                                       | Unchanged                                                                                                                      |
|                                    | Significant production of particulates associated with drill pad construction and transportation of drilling equipment; dust raised by casual traffic | Location construction; all phases | --                                      | --                  | --                                                                                       | Unchanged                                                                                                                      |
|                                    | Accidental explosions, fires, blowouts                                                                                                                | Production                        | --                                      | --                  | --                                                                                       | Unchanged                                                                                                                      |
| Topography                         | Slumps; alteration of landscape character (on a local basis)                                                                                          | APD                               | 7, 8*, 17, 19, 29, 31, 32, 33, 34a, 34b | All locations       | Moderately effective                                                                     | In hilly areas it is impossible to totally restore the original topography. Slumps are still likely to occur in steep terrain. |
| Soils, Water Resources, Vegetation | Blading, unnecessary dirtwork                                                                                                                         | Geophysical exploration           | 1*                                      | At all times        | Moderately effective; this measure is currently being used, but is difficult to enforce. | Unnecessary dirtwork will be avoided in most cases; basic dirtwork will still occur. Impacts will be minor.                    |

NOTE: For explanation of terms used, see last page of table.



TABLE 3-1  
(continued, page 2)  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

| RESOURCE VALUE | IMPACT                                                                                               | PHASE                                            | MITIGATING MEASURE NO.                           | CONDITION WHEN USED                                                                            | EFFECTIVENESS/FEASIBILITY                                                                                                                                            | RESIDUAL IMPACT                                                                                                                                                                                                                                                                                                               |
|----------------|------------------------------------------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------|------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | Unnecessary damage to vegetation, soil by overland travel or exploration activity during wet weather | Geophysical exploration                          | 2*                                               | When soil is wet or snow covers ground                                                         | This measure is currently being used, but is difficult to enforce.                                                                                                   | Little activity occurs during winter months because of increased costs of clearance for access, etc. However, such activity needs to be further monitored. Visible two-track disturbances are many times interpreted as a road; use of such tracks during fall months can lead to unwanted or unnecessary road establishment. |
|                | Loss of vegetative cover; invasion of undesirable species                                            | Geophysical exploration                          | 3*, 4*, 5*, 6*                                   | Required for all surface disturbance                                                           | Soil testing, vegetative density guides show adequacy of cover. Bond is held until seeding takes.                                                                    | Prompt rehabilitation reduces likelihood of invasion of undesirable species.                                                                                                                                                                                                                                                  |
|                | Soil erosion (soil removal)                                                                          | Well location and access road construction (APD) | 7, 10, 11, 17, 18, 20, 24<br>9<br>19<br>Lease #1 | --All locations<br>--Fragile areas<br>--Backslopes greater than 50%<br>--Severe erosion hazard | These measures can be highly effective in reducing soil erosion, but are not always carried out. Lack of manpower (compliance personnel) contributes to the problem. | Impacts cannot be entirely mitigated. There will still be some erosion occurring.                                                                                                                                                                                                                                             |
|                | Improper road construction                                                                           | APD                                              | 7, 8, 22, 23, 24                                 | All road work                                                                                  | Moderately effective                                                                                                                                                 | Major impacts of soil erosion, sediment load can be reduced, but will still occur.                                                                                                                                                                                                                                            |

TABLE 3-1  
(continued, page 3)  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

| RESOURCE VALUE | IMPACT                                                                                               | PHASE                | MITIGATING MEASURE NO. | CONDITION WHEN USED                                             | EFFECTIVENESS/FEASIBILITY                                                                                                 | RESIDUAL IMPACT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------|------------------------------------------------------------------------------------------------------|----------------------|------------------------|-----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | Pollution of surface or groundwater, erosion, contamination of soil material, soil mixing and burial | APD                  | 12                     | --Slopes greater than 25%;                                      | Highly effective if done properly. In the past, these measures have not uniformly been used where necessary or desirable. | Even with proper procedures, pits may rupture leading to water and soil pollution and soil erosion. Because of lack of manpower (compliance personnel) these measures are not always applied. The result in some instances is contaminated surface and groundwater and accelerated soil erosion. There is no way to mitigate soil mixing or burial (the result is often lowered productivity). Mixing of water from different aquifers and leakage of toxic material into shallow aquifers may still occur (0.5%-1% of the wells drilled). |
|                |                                                                                                      |                      | 13                     | --Slope 10-25%;                                                 |                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                |                                                                                                      |                      | 14                     | --Sandy soil or slope 10-25%;                                   |                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                |                                                                                                      |                      | 15                     | --All locations with watersheds greater than 5 acres above them |                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                |                                                                                                      |                      | 16                     | --All locations with reserve pits made of porous material       |                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                | Soil, water pollution and soil erosion                                                               | Dry hole/abandonment | 20                     | --All locations                                                 | Highly effective if properly carried out                                                                                  | None.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                |                                                                                                      |                      | 21                     | --Wells within 1/2 mile of existing water wells                 |                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                |                                                                                                      |                      | 28, 29                 | All locations                                                   |                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                | Soil erosion                                                                                         | Dry hole/abandonment | 29, 34a, 40, 41        | All locations                                                   | Moderately to highly effective                                                                                            | Erosion will not be completely eliminated, but with proper control measures, including mulching, and waterbars, erosion can be kept within tolerance levels especially for slopes up to 15%. Reclamation of slopes from 15%-30% is difficult.                                                                                                                                                                                                                                                                                              |
|                |                                                                                                      |                      |                        |                                                                 |                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |



TABLE 3-1  
(continued, page 4)  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

| RESOURCE VALUE | IMPACT                                    | PHASE                    | MITIGATING MEASURE NO.                                                                         | CONDITION WHEN USED                                                                                             | EFFECTIVENESS/FEASIBILITY                                                                                                                                                                                                                                                                                                       | RESIDUAL IMPACT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------|-------------------------------------------|--------------------------|------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | Soil compaction                           | Dry hole/<br>abandonment | 30                                                                                             | All locations                                                                                                   | Highly effective                                                                                                                                                                                                                                                                                                                | If stipulation is followed compaction should be minimized.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                | Loss of vegetative cover and productivity | Dry hole/<br>abandonment | 31, 32,<br>33*, 36,<br>37, 38,<br>39, 43,<br>Lease #3<br>35<br><br>34a, 34b,<br>Lease #2<br>41 | --All locations with NE, N, NW, W, and SW slopes<br>--Sandy locations or slopes greater than 25%<br>--All roads | Moderately to highly effective. Certain types of seeds may be difficult to obtain. Productivity can be restored to 87% of original capacity. With proper handling, 90-95% of topsoil can be retained. Fencing rehabilitated locations in heavy grazing areas is economically feasible and will help ensure success of seedings. | Grasses are relatively successful for rehabilitation. Without planting shrubs or forbs, 10 years or more may be required for natural reestablishment. The impact of weeds will be lessened, but not eliminated. Healing time will be reduced with successful rehabilitation techniques. Long term loss of productivity is 13%. Species diversity is reduced. Seedings take 2-3 years to become established; natural rehabilitation can take up to 10 years. Lack of manpower to oversee stipulations has resulted in light to moderate impacts on vegetation. |

TABLE 3-1  
(continued, page 5)  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

| RESOURCE VALUE | IMPACT                                             | PHASE                  | MITIGATING MEASURE NO.                                                                                                                                                                                                                                                                                               | CONDITION WHEN USED                                                 | EFFECTIVENESS/FEASIBILITY | RESIDUAL IMPACT                                                                                                                          |
|----------------|----------------------------------------------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
|                | Poorly maintained or reclaimed locations and roads | Production/abandonment | Promptly initiate action to pull re-habilitation bonds for locations or abandoned roads where reclamation has been unsuccessful or improperly done. Reshaping, erosion protection, and planting shall be complete within 2½-3 years from abandonment or from date of production for unused portions of the location. | Where locations or abandoned roads have not properly been reclaimed | Highly effective          | Proper and timely rehabilitation of unused portions of producing locations, abandoned locations, and abandoned roads will be encouraged. |



TABLE 3-1  
(continued, page 6)  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

| RESOURCE VALUE | IMPACT                               | PHASE         | MITIGATING MEASURE NO. | CONDITION WHEN USED                                      | EFFECTIVENESS/FEASIBILITY                                                            | RESIDUAL IMPACT                                                                                                                                        |
|----------------|--------------------------------------|---------------|------------------------|----------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | Soil erosion                         | Production    | 43, 44, 45, 47         | All locations                                            | Moderately to highly effective. Unnecessary erosion will be prevented.               | Some erosion will still occur as a result of authorized roads and dirtwork.                                                                            |
|                | Loss of vegetative cover             | Production    | 42<br>47               | --All locations<br>--Stream crossings or drainage canals | --See loss of vegetative cover, above<br>--Highly effective if seeding is successful | See loss of vegetative cover, above.                                                                                                                   |
|                | Noxious weed invasion                | Production    | 46                     | All access roads                                         | Moderately to highly effective                                                       | Weed invasion will be reduced, but not eliminated, in most cases. Residual effect of chemical treatments is unknown.                                   |
|                | Soil erosion, vegetative disturbance | Rights-of-way | 49*, 50*, 52, 53       | All rights-of-way                                        | Moderately to highly effective if properly executed                                  | Severe erosion will be curbed; remaining erosion will be within tolerance limits. Success of rehabilitation will be limited in areas of heavy grazing. |
| Fire           |                                      | Rights-of-way | 51*                    | All rights-of-way                                        | Highly effective                                                                     | None.                                                                                                                                                  |

TABLE 3-1  
(continued, page 7)  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

| RESOURCE VALUE | IMPACT                                                                                            | PHASE | MITIGATING MEASURE NO. | CONDITION WHEN USED                                                       | EFFECTIVENESS/FEASIBILITY     | RESIDUAL IMPACT                                                                                                                                                                                                           |
|----------------|---------------------------------------------------------------------------------------------------|-------|------------------------|---------------------------------------------------------------------------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wildlife       | Disturbance/displacement of elk in critical winter/calving ranges even with seasonal restrictions | All   | 54                     | Seasonal: winter range Nov. 1 to Apr. 30; calving range Apr. 1 to June 30 | Highly effective, if observed | Disturbance due to seismic activity eliminated. Impacts of the presence of wells and roads unchanged.                                                                                                                     |
|                | Disturbance to sharp-tailed and sage grouse                                                       | All   | 55                     | Presence of leks                                                          | Highly effective              | Some nests may still be disturbed since not all birds nest within the stipulated buffer zone (about 20%). Some disruption of mating or courting activities may still occur.                                               |
|                | Disturbance/displacement of raptors, including bald eagles                                        | All   | 56, Lease #5           | Raptor nests; eagle roosts (1 mi.) (geophysical exploration only)         | Highly effective              | Some raptors may still desert their nests, but the rate should be low. Biggest problem is knowing where nests are, since inventories are inadequate for Sheridan and Johnson counties. Impacts to eagle roosts unchanged. |
|                | Disturbance to black-footed ferrets                                                               | APD   | 57                     | Presence of prairie dog towns                                             | Highly effective              | Verification of prairie dog towns at APD time will nearly eliminate possible impact to ferrets.                                                                                                                           |



TABLE 3-1  
(continued, page 8)  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

| RESOURCE VALUE | IMPACT                                                                                            | PHASE                     | MITIGATING MEASURE NO. | CONDITION WHEN USED                 | EFFECTIVENESS/FEASIBILITY                                            | RESIDUAL IMPACT                                                                                                                                                                                            |
|----------------|---------------------------------------------------------------------------------------------------|---------------------------|------------------------|-------------------------------------|----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | Destruction of big game habitat/cover provided by juniper, pine, and aspen                        | All                       | 32                     | Presence of juniper, pine, or aspen | Highly effective                                                     | Where trees are removed, such as when roads are built through stands of trees, escape cover will be reduced. It will take 10-15 years after rehabilitation for trees to grow tall enough to provide cover. |
|                | Destruction of deer and elk forage                                                                | All                       | 32, Lease #4           | Presence of mountain browse         | Highly effective                                                     | Forage production will be reduced for 10-15 years.                                                                                                                                                         |
|                | Waterfowl deaths resulting from birds landing in reserve pits                                     | APD                       | 58                     | All reserve pits                    | Highly effective                                                     | A few birds would still be lost, but most would be discouraged from landing in oily pits.                                                                                                                  |
|                | Poaching, overharvest of big game                                                                 | APD, dry hole/abandonment | 40, 41, 45, Lease #4   | Unneeded roads                      | Low to moderate. Poaching and ORV activity are difficult to control. | Game populations could be reduced for the life of the project.                                                                                                                                             |
|                | Contamination of fisheries by runoff or spills; contamination of water sources for other wildlife | APD                       | 20                     | All locations                       | Highly effective if properly executed                                | None.                                                                                                                                                                                                      |

TABLE 3-1  
(continued, page 9)  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

| RESOURCE VALUE     | IMPACT                                                                                                                                                                                     | PHASE              | MITIGATING MEASURE NO.                    | CONDITION WHEN USED                     | EFFECTIVENESS/FEASIBILITY                                                                                  | RESIDUAL IMPACT                                                                                                                                        |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------------------------|-----------------------------------------|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
|                    | Added silt load in waterways from stream crossings                                                                                                                                         | APD                | 23, Lease #4                              | All stream crossings                    | Moderately effective                                                                                       | The sediment load added to streams will be reduced but not eliminated.                                                                                 |
|                    | Movement of soil by earthmoving equipment directly kills small mammals, reptiles, and destroys songbird nests. Construction of roads and locations destroys some habitat for life of well. | APD, Rights-of-way | None                                      | --                                      | --                                                                                                         | Unchanged, but losses to regional populations would be insignificant.                                                                                  |
|                    | Electrocution of raptors                                                                                                                                                                   | Rights-of-way      | 59*, 60*                                  | Power line construction, as appropriate | Highly effective                                                                                           | Proper construction of power lines can prevent raptor electrocution.                                                                                   |
| Cultural Resources | Disturbance of site features, crushing of artifacts, compression and displacement of near-surface deposits                                                                                 | All                | 61*, 62*, 63*, site specific stipulations | Prior to surface disturbing activities  | Moderate effectiveness. Depends on ethical treatment of resource by those involved in surface disturbance. | Still potential for disturbance of the resource. Inventory will add to our knowledge of cultural resources. National Register sites will be protected. |
|                    | Artifact removal and information loss                                                                                                                                                      | All                | --                                        | --                                      | --                                                                                                         | Unchanged                                                                                                                                              |



TABLE 3-1  
(continued, page 10)  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

| RESOURCE VALUE   | IMPACT                                                        | PHASE         | MITIGATING MEASURE NO. | CONDITION WHEN USED                        | EFFECTIVENESS/FEASIBILITY                                                                                                           | RESIDUAL IMPACT                                                                                                                                                                                        |
|------------------|---------------------------------------------------------------|---------------|------------------------|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                  | Disturbance to sub-surface cultural resources                 | All           | 62*, 63*               | Prior to surface disturbance               | Moderately effective if strips are followed and individuals involved with surface disturbance observe and report cultural evidence. | Unchanged for dispersed sites or sites of low visibility.                                                                                                                                              |
|                  | Identification of highly visible sites in subsurface deposits | All           | 62*, 63*               | Where subsurface deposit is present        | Effective if archeologist is present during dirt work.                                                                              | Potentially destructive for sites, if impacting project cannot avoid subsurface cultural resources. Data recovery procedures may destroy sites before their full research potential can be recognized. |
| Visual Resources | Visual intrusion                                              | APD           | 64, 65                 | --All locations                            | --Impact reduced up to 50%, depending on topography                                                                                 | --In flat or rolling terrain, visual intrusion will be seen.                                                                                                                                           |
|                  |                                                               | Production    | 66                     | --Visual Resource Management Class II area | --Good                                                                                                                              | --Some visual impact will remain, but should be small.                                                                                                                                                 |
|                  | Production                                                    | 67, Lease #6  |                        | --For permanent facilities                 | --Will reduce contrast of permanent facilities. Screening will reduce visibility of structures.                                     | --Some contrast of facilities against the surrounding areas will remain; screening not effective in flat areas.                                                                                        |
|                  |                                                               | Rights-of-way | 68                     | --For roads, power lines, pipelines        | --Will reduce some obvious impacts, will increase costs.                                                                            | --Roads, power lines, pipelines will be evident, but will be less obvious at greater distances.                                                                                                        |
|                  | Litter                                                        | APD           | 25*                    | All locations                              | 100% effective if complied with or enforced.                                                                                        | None.                                                                                                                                                                                                  |

TABLE 3-1  
(continued, page 11)  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

| RESOURCE VALUE      | IMPACT                                                        | PHASE                   | MITIGATING MEASURE NO.  | CONDITION WHEN USED                                         | EFFECTIVENESS/FEASIBILITY                   | RESIDUAL IMPACT                                                                                                                       |
|---------------------|---------------------------------------------------------------|-------------------------|-------------------------|-------------------------------------------------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Recreation          | Creation of areas undesirable for some recreationists         | All                     | 64-68                   | As above                                                    | Impacts can be reduced, but not eliminated. | Impacts on aesthetics will still occur, although to a lesser extent. Recreation potential will be reduced where fields are developed. |
|                     | Increased access                                              | APD Production          | --                      | --                                                          | --                                          | Unchanged                                                                                                                             |
|                     | Creation of intensive use areas; off-road vehicle travel      | All                     | --                      | --                                                          | --                                          | Unchanged                                                                                                                             |
| Other Minerals      | Conflict with coal                                            | APD                     | 69*, 70*, 71*, Lease #7 | For well locations in an area of an approved coal mine plan | Highly effective                            | None.                                                                                                                                 |
|                     | Mineral trespass                                              | APD                     | 72                      | --                                                          | Moderately effective                        | Some inadvertent trespass may still occur.                                                                                            |
| Ranching Operations | Disturbance to range improvements, vegetation                 | All                     | 73, 74, 75              | --                                                          | Moderately to highly effective              | Sometimes, rehabilitation is unsuccessful. Fences not always repaired adequately.                                                     |
|                     | Gates left open, allowing livestock to drift between pastures | Geophysical exploration | --                      | --                                                          | --                                          | Unchanged.                                                                                                                            |



TABLE 3-1  
(continued, page 12)  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

| RESOURCE VALUE | IMPACT                                                                      | PHASE         | MITIGATING MEASURE NO. | CONDITION WHEN USED              | EFFECTIVENESS/FEASIBILITY                                                                               | RESIDUAL IMPACT                                                                                                                                                                                |
|----------------|-----------------------------------------------------------------------------|---------------|------------------------|----------------------------------|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | Undesirable road location                                                   | APD           | 76                     | All access on private surface    | Highly effective                                                                                        | Incidence of roads in the wrong place can be reduced to a minimum.                                                                                                                             |
|                | Hazard of pits to livestock-contaminated water; livestock get mired in mud. | APD           | 77                     | All pits and ponds               | Highly effective                                                                                        | None.                                                                                                                                                                                          |
|                | Disruption of calving or lambing operations                                 | APD           | 78                     | During calving or lambing season | Highly effective. Feasibility depends on specific situations and coordinations with livestock operator. | None.                                                                                                                                                                                          |
|                | Hazard of pipelines to livestock                                            | Rights-of-way | 79                     | For all pipelines                | Highly effective. Would require surface rehabilitation.                                                 | None to livestock; rehabilitation would result in loss of species diversity.                                                                                                                   |
|                | Livestock struck by fast-moving vehicles                                    | All           | --                     | --                               | --                                                                                                      | Unchanged.                                                                                                                                                                                     |
| Lands          | Congestion resulting from proliferation of rights-of-way                    | APD           | 68                     | Where corridors can be used      | Moderately effective                                                                                    | It is not always possible to route rights-of-way in existing corridors. This is especially true of rights-of-way serving individual wells. Pipeline rights-of-way in particular are difficult. |

TABLE 3-1  
(continued, page 13)  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

| RESOURCE VALUE                                           | IMPACT                         | PHASE | MITIGATING MEASURE NO. | CONDITION WHEN USED                                                                     | EFFECTIVENESS/FEASIBILITY                                                                                          | RESIDUAL IMPACT                                                                                                                                                                   |
|----------------------------------------------------------|--------------------------------|-------|------------------------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Residential Areas (city subdivisions or ranch dwellings) | Indiscriminate development     | APD   | 80, Lease #8           | Operation $\frac{1}{2}$ mile from dwelling                                              | Moderately effective--depends on willingness of operator to comply with comments.                                  | Major impacts may be reduced, but any development within $\frac{1}{2}$ mile of a residence will have an impact.                                                                   |
|                                                          | Contamination of aquifers      | APD   | 81                     | Operation near residences                                                               | Highly effective                                                                                                   | None.                                                                                                                                                                             |
|                                                          | Traffic hazard, dust abatement | APD   | 82<br>83<br>84         | -- $\frac{1}{2}$ mile from dwelling<br>--500' of any dwelling<br>--roads in subdivision | --Moderately effective; not easily enforced.<br>--Moderately effective; not easily enforced.<br>--Highly effective | Other vehicles may use these roads and not observe stipulated speed limits. Dust will continue to be a problem; traffic will still be a hazard, but roads would be in good shape. |
|                                                          | Noise                          | APD   | 85, 90                 | $\frac{1}{2}$ mile from dwelling                                                        | Highly effective                                                                                                   | None.                                                                                                                                                                             |
|                                                          | Nuisance                       | APD   | --                     | --                                                                                      | --                                                                                                                 | --                                                                                                                                                                                |
|                                                          | Safety hazards                 | APD   | 86<br>89               | -- $\frac{1}{2}$ mile from dwelling<br>--500' from dwelling                             | Highly effective                                                                                                   | None.                                                                                                                                                                             |
|                                                          | Litter, waste products         | APD   | 87, 88                 | Residential areas                                                                       | Highly effective                                                                                                   | None.                                                                                                                                                                             |
|                                                          | Visual intrusions              | APD   | 91, 91, 93             | Residential areas                                                                       | Moderately effective                                                                                               | Major impacts will be reduced, but not eliminated.                                                                                                                                |



TABLE 3-1  
 (continued, page 14)  
UNAVOIDABLE ADVERSE IMPACTS/SURFACE PROTECTION GUIDANCE

TERMS USED:

The "impacts" listed are brief descriptions of the impacts described in Chapter 2.

The effectiveness of a mitigating measure means how well it works and whether it is reasonable in terms of enforcement and/or operator acceptance.

A "highly effective" mitigating measure is one which is reasonable and alleviates most or all of the impact.

An "unchanged" residual impact means there is no appropriate mitigating measure and the impact identified in Chapter 2 cannot be reduced.

## RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Short-term use consists of occupying the land at each well location for the purpose of production of oil and gas for a period of 25 to 50 years until the oil and gas supply is depleted. Long-term productivity is the continued use of the land by other activities such as grazing, wildlife use, and recreation. These uses are presently being made of the land and will continue after oil and gas production ceases, although they may be decreased.

The impact on air quality is relatively short-term and primarily exists when oil and gas production is continuing. Revegetation/rehabilitation of drill pads and other disturbed areas results in a reduction of some of the dust pollution. However, some pollution by dust and gaseous emissions due to off-road vehicle traffic related to increased access may continue after oil and gas production ceases.

Water quality, like air quality, will improve when oil and gas production ceases, but some water pollution will continue to occur through runoff from disturbed areas until those areas are revegetated and stabilized. Toxic substances deposited in drainages could pollute natural runoff for long periods of time.

As wells are abandoned, disturbed areas are revegetated and returned to other uses. However, these sites may not return to the same level of productivity as before oil and gas production began. Some of the sites could possibly produce more vegetation and some will undoubtedly produce less. In most cases, these disturbed areas will not be the same due to the availability of suitable seed types, difficulty of reestablishing some of the native species, and changes in soil composition which permanently affect plant communities and succession. Use by animals is greatly dependent upon the vegetation present or the success in reestablishing vegetation.

Short-term use of the lands for general exploration activities does not as a rule impair long-term productivity for wildlife. If oil and gas is found, however, subsequent development and production can have a long-term effect on wildlife through loss of crucial wintering, breeding, production, and migration areas. In these cases, both the habitat and wildlife can be lost. After production and site abandonment, the ecosystem may never be entirely rehabilitated. Thus, wildlife formerly found in the area may never again use it due to changes in land patterns and use.

Smaller, more adaptive wildlife species, such as ground squirrels, rabbits and other mammals, birds, and insects and the small predators that depend on them, may reinhabit the peripheral zones of their former habitat.

Gully erosion as the result of stream crossings and other construction activities alters riparian habitat, and reduces watershed productivity for other uses.

Short-term use of oil and gas locations with cultural resources near them can sometimes be beneficial, particularly in areas where little knowledge has been previously available. On the other hand,



short-term use may represent the least efficient use of the cultural resource because of the state-of-the-art at time of discovery and the "hurry-up" protection and salvage methods dictated. Short-term uses that alter or destroy cultural resource sites have long-term impacts on the productive value of those resources. The greatest danger is complete loss of a cultural resource by obliteration due to lack of knowledge of its existence.

Visual resources are altered in the short-term by site development as well as by road, pipeline, and utility line construction.

Much of the land which is now committed solely to single use for oil and gas production will become available for other uses as wells are abandoned and rehabilitated. However, some of the permanent structures such as roads will not be removed.

Several beneficial long-term impacts can result from oil and gas activities, besides the obvious benefit from availability of petroleum products. The oil and gas industry lends stability to local economies. Increased access can be of benefit to ranching operations and to recreationists. Many roads associated with the industry are maintained better than county roads. Useable water resulting from oil and gas exploration and development can benefit vegetation, wildlife, and ranching operations. Seeding locations in shrubby areas increases the amount of "edge" habitat for wildlife. Introduction of electric power increases range improvement/development possibilities.

## IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The most apparent commitment of resources is the extraction and eventual consumption of oil and gas from the area. However, there are also irrevocable changes in surface resources, human interest values, and land use.

Paleontological and archaeological resources are subject to partial or total destruction by any surface or subsurface disturbance if they have not been identified and accounted for in the plan of operation. If salvage of these sites is done hastily, there is a chance that the maximum values of more deliberate work would not be attained.

The vegetation and animals lost to oil and gas activities can in theory be replaced by rehabilitating the sites; however, the growth lost during the period when the site is not producing can never be replaced.

Excessive sedimentation can cause irretrievable changes in aquatic habitat when stream channels, lakes, marshes, or reservoirs become filled with sediment. These habitats are no longer capable of producing the quantities of fish they once did unless the sediment is physically removed, which is generally considered impractical.

Some soils heavily oil soaked or eroded away would represent irreversible losses. Groundwater aquifers can suffer permanent loss of water quality because of contamination with pollutants.

There is a substantial amount of fossil fuel and electrical power expended in all phases of oil and gas production.





CHAPTER 4  
CONSULTATION AND COORDINATION

LIST OF PREPARERS

|                 |                                                           |
|-----------------|-----------------------------------------------------------|
| Bob Wilber      | District Manager                                          |
| Julie Elfving   | Team Leader                                               |
| Mary Sue Waxler | Assistant Team Leader, Writer/Editor                      |
| Jerry Crockford | Surface Protection, Soils, Air Quality,<br>Other Minerals |
| Ed Bunger       | Soils, Water Resources                                    |
| Jayne Williams  | Land Uses, Rights-of-Way                                  |
| Mike Giorgis    | Recreation, Visual Resources, Wilderness                  |
| Ray Lister      | Vegetation, Ranching                                      |
| Mike McLellan   | Wildlife                                                  |
| Manton Botsford | Cultural Resources                                        |



## PUBLIC PARTICIPATION AND ENVIRONMENTAL ASSESSMENT SCOPING

A workshop was held in the Casper District Bureau of Land Management (BLM) Office on June 5, 1979, to help determine what major issues should be discussed in the oil and gas environmental assessment (EA). A list of potential workshop participants was compiled from suggestions made by resource specialists in the Buffalo, Casper, and Wyoming State BLM offices. Thirty-six people, including ranchers (6) and representatives of state and other federal agencies (10), environmental protection groups (6), public utility companies (2), construction contracting companies (2), and the oil and gas industry (10) were invited to attend. Twenty-one attended (see Table 4-1).

The purpose of the workshop was twofold: to solicit public participation in the environmental analysis and to help determine the scope of the EA, i.e., what impacts, issues, and mitigating measures should be discussed. Both objectives are mandated by the Council on Environmental Quality regulations, published in 1978.

A BLM press release describing the workshop and the purpose and scope of the EA was sent to all district news media on June 5, 1980. KTWO TV (Casper) and the Casper-Star-Tribune sent representatives to the workshop. Their reports were subsequently broadcast or published on June 5 and June 6, 1980, respectively.

Problems and issues brought out at the workshop, as well as those of concern to BLM managers, are incorporated in this document.

TABLE 4-1

WORKSHOP ATTENDANCE

Bob Wilber, BLM, Casper District Manager  
Julie Elfving, BLM, Chief, Branch of Environmental Analysis  
Lee Keesling, BLM, Public Information Officer  
Warren Wilson, Casper-Star-Tribune  
Bob Lunstrom, KTWQ

Workgroup 1 -- Leasing and Resource Protection

Frosty Littrell, BLM, Buffalo Resource Area Manager  
Dennis Law, BLM, Landscape Architect  
Leo Coleman, BLM, Natural Resource Specialist  
Jack Savini, Powers Elevation, Archeologist  
Bruce Hamilton, Sierra Club  
Steve Amstrup, U.S. Fish and Wildlife Service, Sheridan  
Fred Floyd, Jr., Rancher  
Jim Collums, Landsman  
Bob Williams, Wyoming Game and Fish Department, Sheridan  
Walt Gasson, Wyoming Game and Fish Department, Gillette

Workgroup 2 -- On-the-Ground Action

Pat Wendt, BLM, Natural Resource Specialist  
Ken Russell, BLM, Natural Resource Specialist  
Eleanor Herbert, Outdoors Unlimited  
Harry Harju, Wyoming Game and Fish Department, Cheyenne  
Rich Marvel, Wyoming State Oil and Gas Commission, Casper  
Jim Pachulski, Geological Survey, Casper  
Ed Haymaker, Haymaker and Associates  
Stan McInroy, McIlroy-Adams and Company, Inc.  
John Iberlin, Rancher  
Nick Nichols/Bob Ryder, Loffland Brothers Company

Workgroup 3 -- Rights-of-Way

Jayne Williams, BLM, Realty Specialist  
Mike McLellan, BLM, Wildlife Management Biologist  
Gary Bauer, BLM, Surface Compliance Engineer  
Bob Gibbs, Sheridan-Johnson REA  
John Sprague, Tri-County Electric Association  
Jim Fleetwood, Western Oil Transportation Company, Inc.  
Jim Kalkowski, Powder River Pipeline, Inc.  
Jack Behling, Amoco Pipeline Company  
Doyle (Bud) Hayden, Rancher



TABLE 4-1

(cont'd)

Workgroup 4 -- Surface Protection in Existing Fields

Jerry Crockford, BLM, Natural Resource Specialist

Mary Sue Waxler, BLM, Writer-Editor

Bill Barlow, Rancher

Frank Lyte, Phillips Petroleum Company

George Darlington, Forest Service, Thunder Basin National Grasslands

LeRoy Feusner, Wyoming Department of Environmental Quality, Water  
Quality Division

John Wagner, Wyoming Department of Environmental Quality, Water  
Quality Division

## CONSULTATION AND COORDINATION DURING PREPARATION OF THE ANALYSIS

In addition to the workshop participants, individuals from the following agencies and groups provided information during the preparation of this environmental assessment.

Forest Service, Experiment Station, Rapid City, S.D.  
Geological Survey, Newcastle  
U.S. Fish and Wildlife Service, Fort Collins and Denver  
Wyoming Department of Environmental Quality, Divisions of Air and  
Land Quality, Cheyenne and Sheridan  
Wyoming Geological Survey, Laramie  
Johnson County Weed and Pest Control Board  
Davis Oil Company, Casper  
Eastman Whipstock, Inc., Casper  
Inexco, Casper  
Marathon Oil Company, Casper  
Plains Engineering, Buffalo  
Texaco, Inc., Moorcroft  
Wyoming Petroleum Association, Casper  
Independent Consultants  
    Marvin Hatcher  
    Dale Heitzman



## COORDINATION IN THE REVIEW OF THE DRAFT ENVIRONMENTAL ASSESSMENT

The draft environmental assessment (EA) was sent for review to each of the workshop participants, as well as to the following individuals, groups, and agencies.

### State

Wyoming State Historic Preservation Officer

### County

Campbell County Commissioners  
Johnson County Commissioners  
Sheridan County Commissioners

### Nongovernment Organizations and Individuals

Davis Oil Company  
Marvin Hatcher  
Dale Heitzman

The following provided review comments on the draft EA.

Forest Service  
Geological Survey  
Wyoming Department of Environmental Quality  
Wyoming State Historic Preservation Officer  
Campbell County, Office of the County Engineer  
John Iberlin

All comments received were considered in preparation of the final EA and are available for review at the BLM Buffalo Resource Area and Casper District offices.

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P.O. BOX 25047  
DENVER, CO 80225

## APPENDIX





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TABLE A-1  
SLOPE CONVERSION CHART

| <u>Percent Slope</u> | <u>Slope in Degrees</u> | <u>Slope Ratio</u> |
|----------------------|-------------------------|--------------------|
| 100%                 | 45°                     | 1:1                |
| 90%                  | 42°                     | 1.11:1             |
| 80%                  | 38°40'                  | 1.25:1             |
| 70%                  | 35°                     | 1.43:1             |
| 60%                  | 31°                     | 1.66:1             |
| 50%                  | 26°30'                  | 2:1                |
| 40%                  | 21°50'                  | 2.5:1              |
| 33.3%                | 18°30'                  | 3:1                |
| 30%                  | 16°50'                  | 3.3:1              |
| 25%                  | 14°9'                   | 4:1                |
| 20%                  | 11°20'                  | 5:1                |
| 16.6%                | 9°25'                   | 6:1                |
| 14.4%                | 8°5'                    | 7:1                |
| 12.5%                | 7°10'                   | 8:1                |
| 11.1%                | 6°20'                   | 9:1                |
| 10%                  | 5°40'                   | 10:1               |



## LAWS AND ENFORCING AGENCIES

During the oil and gas workshop held June 5, 1979, several problems of an administrative nature were discussed. Some landowners and industry representatives said they had difficulty keeping track of laws and requirements for oil and gas activities, as well as the administering agencies. They requested that a list of these items appear in the environmental analysis. The list follows. It is supplemented by the booklet Oil and Gas: Surface Operating Standards for Oil and Gas Exploration and Development, written by the Bureau of Land Management, Geological Survey, and the Forest Service.

### Air Quality

The Clean Air Act of 1970 specified that each state would be responsible for ensuring the air quality within its borders and for specifying the way that quality would be achieved and maintained.

On April 30, 1971, the Environmental Protection Agency (EPA) officially announced the primary and secondary National Ambient Air Quality Standards (NAAQS) (Federal Register, April 30, 1971). The primary standards were established to protect human health, whereas the secondary standards were established to protect the public welfare from any known or anticipated adverse effects. Standards were put into effect for suspended particulate matter, sulfur oxides, nitrogen oxides, photochemical oxidants, carbon monoxide, and hydrocarbons (see Table 2-6).

The Wyoming ambient air quality standards were put into effect in accordance with the Wyoming Environmental Quality Act. On January 22, 1972, the State of Wyoming adopted air quality regulations that were slightly more stringent with respect to total suspended particulates (TSP) and sulfur dioxide (SO<sub>2</sub>) than the NAAQS regulations. Under Article 2 of the act, the Air Quality Division of the Wyoming Department of Environmental Quality (DEQ) is empowered to enforce these air quality standards (see Table 2-6). DEQ also issues burning permits.

Responsibility for the control of hydrogen sulfide gas emissions is delegated to the Geological Survey (GS) in Title 30 CFR Part 221, which is based on the Mineral Leasing Act of 1920, as amended.

The Wyoming State Oil and Gas Commission regulates the flaring or venting of natural gas.

### Minerals Management

Federal regulations controlling oil and gas activity are based on the Mineral Leasing Act of 1920, as amended. This act encourages development of leasable minerals, establishes time limits and royalties for oil and gas leases, sets up competitive and noncompetitive leasing systems, and decrees that the draining or waste of federal reserves will be prevented.

GS is responsible for enforcing regulations pertaining to coal mining in oil and gas fields (Title 30 CFR Part 211), and to production, royalties, and operating requirements on federal leases (Title 30 CFR Part 221).

The Bureau of Land Management (BLM) administers regulations for geophysical exploration (Title 43 CFR Part 3045) and for leasing procedures and surface protection (Title 43 CFR Part 3100).

The Wyoming State Oil and Gas Commission works with GS, but retains final approval authority, for well locations and spacing, unit agreements, water and gas injection systems, and underground gas storage projects. Oil and gas operators are required to obtain permission to drill from the Commission, and must follow state procedures for plugging dry holes and/or submitting production reports.

The Wyoming State Commissioner of Public Lands issues and administers oil and gas leases on state lands.

### Water Quality

Specific applicable legislation and regulations include:

1. Federal Water Pollution Control Act (FWPCA), as amended in 1972
2. Wyoming Environmental Quality Act of 1973, including the Wyoming Abandoned Drill Hole Act (35-502.22:1)
3. Water Quality Standards for Wyoming, Wyoming Department of Health and Social Services, June 28, 1973, superseded by Quality Standards for Wyoming Surface Waters, June 6, 1978

National standards to restore and maintain the chemical, physical, and biological integrity of the nation's waters were promulgated by the FWPCA.

Wyoming water quality standards were issued in accordance with the Wyoming Environmental Quality Act of 1973. Under Article 3 of the act, DEQ's Water Quality Division is empowered to enforce these water quality standards. Important prescribed standards include those which specify maximum short-term and long-term concentrations of pollution, minimum permissible concentrations of dissolved oxygen and other matter, and the permissible temperatures of the waters of the state. Effluent standards and limitations specifying the maximum amounts of pollution (including oil and grease) and waste which may be discharged into state waters are described. Other health and water quality standards pursuant to Section 402(b) of the FWPCA are also described. Water quality standards are generally established on the basis of ultimate water use. Thus standards for municipal water vary from those for agricultural water use.

DEQ also issues production water discharge permits.

Water quality planning is required by Section 208 of the FWPCA. The State of Wyoming is responsible for setting water quality standards and developing all "208 plans"; however, the Environmental Protection Agency (EPA) plays a monitoring and arbitration role in the process.



## Oil Spills

Discharge of oil and hazardous materials into permanent and intermittent drainages in Wyoming is prohibited by the Federal Water Pollution Control Act and/or Wyoming Water Quality Rules and Regulations, Chapter IV.

EPA has issued regulations affecting all oil and gas lessees and operators (Title 40 CFR Part 112). These regulations require owners or operators to prepare Spill Prevention Control and Countermeasure Plans (SPCC Plans) for hazardous materials.

In the event of an oil spill, notification of EPA, GS, BLM, and DEQ is required, and the operator is responsible for cleaning up the spill.

## Water Rights

Wyoming water laws state that priority of appropriation for beneficial use shall be given the better right, and that in the order of preferred use, water for drinking purposes for both man and beast shall be first.

Wyoming laws, in part, also provide that whenever a well withdrawing water for beneficial purposes shall interfere unreasonably with an adequate well developed solely for domestic or stock use, the State Engineer may, on complaint of the operator of the domestic or stock well, order the interfering appropriator to cease or reduce withdrawals of underground water, unless such appropriator furnishes at his expense, sufficient water at the former place of use to meet the need for domestic and stock use.

The laws also provide that private property shall not be taken or damaged for public or private use without just compensation. A water right is private property.

An oil and gas operator must obtain a permit from the State Engineer for the use of surface or subsurface water for drilling. If the water is on federally owned surface, BLM must grant access to it.

## Solid Waste Disposal

Applicable regulations include the Wyoming Solid Waste Management Rules and Regulations of 1975; these provide for submission of solid waste disposal plans to the state by every person or municipality proposing such disposal.

## Vegetation and Wildlife

The Endangered Species Act of 1973 provides protection for species (both flora and fauna) listed by the U.S. Fish and Wildlife Service (USFWS) as threatened or endangered. Such species may not be killed, captured, or harassed; and commerce in live animals or plants or parts of dead ones is prohibited. Prior to authorization of any

federal action, the Department of the Interior will require that a survey be made to determine if listed species or their habitat may be present. If it is determined that listed species or their habitat may be present and could be affected by the proposed activities, appropriate consultation with the USFWS will be carried out. No activities will be authorized until consultation is completed as per 50 CFR 402 (January 4, 1978).

The Bald Eagle Protection Act of 1940 originally protected the bald eagle but was later amended to include the same protection for golden eagles. USFWS is responsible for enforcing the act. Eagles are protected from all forms of harassment, shooting, poisoning, and capture. Their nests and eggs are also protected from being taken or collected.

The Migratory Bird Treaty Act of 1918 implements a treaty with Great Britain and a later one with Mexico for the protection of migratory game and nongame birds. Regulations pursuant to the act make it unlawful to take, pursue, kill, or capture a bird (or its nest or eggs) considered to be migratory except during certain months of the year. Certain bird families are considered nongame and there is a permanent closed season on these species. USFWS is responsible for enforcing regulations under this act. Losses of waterfowl in reserve pits and destruction of raptor nesting sites during road construction could be considered "taking" as defined in Title 50 CFR Part 21.

The Wyoming Department of Game and Fish is responsible for enforcing laws protecting resident game and nongame populations. Taking game animals is regulated by the use of seasons, bag and sex limits, and weapons restrictions.

County Weed and Pest Control Boards enforce the Wyoming Weed and Pest Act of 1973 which requires that landowners or lessees control the growth of noxious weeds on private, state, or federal land. A list of noxious weeds identified in Wyoming is shown in Table A-2. The county boards, in cooperation with EPA, provide rulings and instructions for the use of herbicides. (The North Platte River Area Designated (Noxious) Weed Treatment Program Environmental Assessment Record, published by the Bureau of Land Management in December 1978, also contains instructions for herbicide application. This document is on file at the BLM Casper District and Buffalo Resource Area offices.) BLM can also require an oil operator to control noxious weeds on federal surface; however, the use of some chemicals on public land is prohibited (see Table A-3).

The Mineral Leasing Act and the Taylor Grazing Act allow the Department of the Interior to convert abandoned oil and gas or production water wells to water wells for range use when such wells contain a freshwater zone.

#### Floodplains Management

Executive Order 11988, May 24, 1977, directs federal agencies to take appropriate actions to avoid, to the extent possible, long and short-term adverse impacts associated with the occupancy and



Table A-2

NOXIOUS WEEDS

This is a list of designated weeds as defined by the Wyoming Weed and Pest Act of 1973, Section 11-69.2.

|                                       |                                                        |
|---------------------------------------|--------------------------------------------------------|
| Field bindweed                        | <u>Convolvulus arvensis</u>                            |
| Canada thistle                        | <u>Circium arvense</u>                                 |
| Leafy spurge                          | <u>Euphorbia esula</u>                                 |
| Perennial sowthistle                  | <u>Sonchus arvensis</u>                                |
| Quackgrass                            | <u>Agrophyron repens</u>                               |
| Hoary cress (Whitetop)                | <u>Cardaria draba</u> and<br><u>Cardaria pubescens</u> |
| Perennial pepperweed (giant whitetop) | <u>Lepidium latifolium</u>                             |
| Ox-eyed daisy                         | <u>Chrysanthemum leucanthemum</u>                      |
| Skeletonleaf bursage                  | <u>Franseria discolor</u>                              |
| Russian knapwee                       | <u>Centaurea repens</u>                                |
| Yellow toadflax                       | <u>Linaria vulgaris</u>                                |
| Dalmation toadflax                    | <u>Linaria dalmatica</u>                               |
| Scotch thistle                        | <u>Onopordum acanthium</u>                             |
| Musk thistle                          | <u>Carduss nutans</u>                                  |
| Common burdock                        | <u>Arctium minus</u>                                   |
| Plumeless thistle                     | <u>Carduus acanthoides</u>                             |
| Wild Oats                             | <u>Avena fatua</u>                                     |
| Dyre's woad                           | <u>Isatis tinctoria</u>                                |

---

Source: Personal communication, Don Hamm, Supervisor, Johnson County Weed and Pest Control Board, March 15, 1974.

TABLE A-3  
U.S. DEPARTMENT OF THE INTERIOR PROHIBITED  
HERBICIDES AND PESTICIDES

Aldrin  
Amitrole  
Arsenical compounds (inorganic)  
Azodrin  
Bidrin  
DDT  
DDD (TDE)  
2,4,5-T  
Dieldrin  
Endrin  
Heptachlor  
Mercurial compounds  
Strobane  
Thallium sulfate  
Toxaphene



modification of floodplains. The executive order further states that federal agencies will avoid direct or indirect support of floodplain development wherever there is a practicable alternative.

#### Protection of Wetlands

Executive Order 11990, May 24, 1977, directs federal agencies to take appropriate actions to avoid, to the extent possible, long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative.

#### Cultural Resources

The legal basis for cultural resources protection dates back to 1906, when the Antiquities Act established provisions for the protection of cultural resources on all federal land. It also provides penalties for those who excavate or appropriate cultural values without an antiquities permit. Court tests of this law have resulted in the writing of a new Antiquities Act bill (presently before Congress) to clarify the definition of objects of antiquity and to increase fines to \$20,000 for the unauthorized removal or destruction of cultural resources on federal land.

The Historic Site Act of 1935 declares it a national policy to identify and preserve for public use historic sites, buildings, objects, and antiquities of national significance for the inspiration and benefit of the people.

The National Historic Preservation Act of 1966 expands national policy toward cultural resources to include those of state and local, as well as national, significance; directs all federal agencies to take into account the effects of their actions on properties included on or eligible for inclusion on the National Register of Historic Places; requires federal agencies to afford opportunities for the Advisory Council on Historic Preservation to comment on proposed actions and their effects; and provides for the withholding from disclosure to the public of information relating to the location of sites or objects listed on the National Register.

Executive Order 11593, passed in 1971, directs all federal agencies to inventory their lands for cultural resources; to submit to the National Register of Historic Places all qualified properties meeting criteria established by the Department of the Interior, and to protect all nominated properties; and to use due caution with all cultural resources until the inventory, evaluation, and nomination processes are completed.

Section 102(a)(8) of the Federal Land Policy and Management Act of 1976 provides that "...the public lands be managed in a manner that will protect the quality of scientific...historic...(and) environmental resources and archeological values." Section 302(b) declares that the Bureau of Land Management has the authority to

regulate, through easements, permits, leases, licenses, and published rules, the use of cultural resources on public lands.

Consultation with the State Historic Preservation Officer (SHPO) is required when a federal action would disturb significant cultural resources. The SHPO is afforded an opportunity to review all federally approved projects.

### Wilderness

Section 603 of the Federal Land Policy and Management Act of 1976 requires that the public lands be inventoried by BLM for wilderness values and possible designation as wilderness. The inventory is divided into two phases, both of which will be completed by September 1980. The first, or initial inventory, identified those lands that obviously do not possess wilderness qualities. The second inventory examines the remaining lands for wilderness characteristics as described in the 1964 Wilderness Act.

Those lands identified in the initial or the second inventory which do not possess wilderness characteristics have been or will be dropped, after public review and approval, from further consideration for wilderness.

Those lands that are identified as wilderness study areas will remain in interim management until BLM makes recommendation for or against inclusion of these lands in the National Wilderness System, and the Congress responds to that recommendation.

Oil and gas leases can be issued in areas being intensively inventoried for wilderness characteristics. A special wilderness protection stipulation is being attached to all leases issued in these areas.

### Lands

Rights-of-way across federal surface for telephone and power lines and roads are issued by BLM under authority of the Federal Land Policy and Management Act of 1976, and according to Title 43 CFR Part 2800. Rights-of-way for oil and gas pipelines are issued by BLM under authority of the Mineral Leasing Act of 1920, and according to the same regulations.

### Pipeline Transmission

Oil and gas operators must meet requirements of the Department of Transportation and the Interstate Commerce Commission as outlined in Title 49 CFR Parts 191 and 192 for transportation of natural gas and oil by pipeline.

### Highways

Wyoming State highway statutes require that any person who negligently damages any street, highway, bridge, or associated structure is liable for its repair or replacement.



## LAND USE PLANS AND CONTROLS

### Jurisdiction

#### Federal

In the Buffalo Resource Area, a large number of separate jurisdictional entities exercise certain types of land and resource use controls. The federal sector includes the Forest Service (FS) (Bighorn National Forest and Thunder Basin National Grasslands) and BLM (public lands and subsurface estate under certain private lands).

Development, management, use, and control of use on public lands is coordinated among the FS, GS, and BLM. Controls are effected through issuance or nonissuance of a variety of leases, permits, licenses, etc. Each authorization to use public lands contains provisions to control that use. Controls exercised by the federal government for the subsurface estate are governed by the statutes authorizing the disposition and use of that estate. Management policy has been extended in greater detail by the National Environmental Policy Act of 1969 and the Federal Land Policy and Management Act of 1976.

#### State

The Wyoming Commissioner of Public Lands is responsible for the administration, leasing, and management of lands owned by the State of Wyoming. Under State of Wyoming statutes, the state is authorized to perform and administer certain surface land use, planning, and development activities on state, county, municipal, and privately owned properties. Legislation which has a significant effect on land use is the Wyoming Environmental Quality Act, the Wyoming State Land Use Planning Act, and the Industrial Development Information and Siting Act.

The State of Wyoming retains jurisdiction over state lands. Some of these lands were conveyed to the state as part of the act admitting Wyoming to the Union. This legislation granted Sections 16 and 36 of every township to the state for educational purposes. Use and control of these lands (including mineral leasing, rights-of-way, etc.) are governed by Wyoming law.

#### County

All three counties have full-time planning staffs, and have developed comprehensive county plans. Under Wyoming statutes, counties have authority to effect a wide variety of controls on state-owned lands in matters not specifically reserved to the state. (The authority applies only to those portions of the county that are unincorporated.) A county may regulate and restrict location and use of buildings and structures, and use, condition of use, or occupancy of lands for residency, recreation, agriculture, industry, commerce, public use, and other purposes. The authority does not apply to any planning or zoning controls over lands used or occupied for the extraction or production of minerals unless reasonably necessary to protect the public good of its citizens.

Less than 1% of the land in the three counties is actually owned by county governments. Use and control of these lands are governed by state law and county ordinances. Control over mineral uses on these lands is vested in the State of Wyoming under the Wyoming Environmental Quality Act of 1973. This act also authorizes the state to control air quality, water quality, and solid waste management.

#### Municipal

Seven incorporated towns or cities lie within the region. These are Buffalo, Clearmont, Dayton, Gillette, Kaycee, Ranchester, and Sheridan. Municipalities have authority to effect master plans, zoning, and other regulatory controls. The Wyoming Environmental Quality Act of 1973 preempts cities' authority to regulate and control air, water, solid waste, and land quality standards except where specifically delegated to municipalities.

Where a county or city lacks a specific authority, provisions of the Wyoming Joint Powers Act are available to enable joint exercise of power, privilege, or authority. This legislation enables two or more agencies to jointly plan, create, finance, and operate (control) water, sewage, solid waste, fire protection, transportation, and public school facilities.

### Land Use Plans

#### Bureau of Land Management

The Buffalo Resource Area Management Framework Plan (MFP) was completed in 1979 for Sheridan, Johnson, and Campbell counties. The MFP is designed to serve as a guide for multiple use resource management and development of the surface of public lands, as well as of the federal mineral estate, much of which lies under privately owned surface.

Specific MFP decisions pertaining to oil and gas are discussed in Chapter 1.

#### Forest Service Planning

Portions of the Thunder Basin National Grasslands and the Bighorn National Forest are located within the Buffalo Resource Area. Multiple use plans (MUPs) covering these areas are in the process of being revised. They establish overall land use objectives and are the basis for all actions within the forest and grasslands. The overall objectives emanate from the Multiple-Use-Sustained-Yield Act of 1960, the Forest and Rangeland Resources Planning Act of 1974, and the National Forest Management Act of 1976.

Two types of federal surface estate are found on FS property: acquired lands and public domain lands. Acquired lands were obtained from private ownership, while public domain lands have always been in public ownership. Both of these surface estates are subject to the above acts. The MUP makes both types of lands available for mineral leasing subject to certain constraints and direction established by FS. The constraints and direction relate to such issues as



maintaining crucial wildlife habitat, maintaining the stability of critical ecosystems, evaluating the reclamation potential of the lands to be leased, and weighing of environmental costs and sensitivities.

#### Local Planning

County and municipal plans make no provisions for, and set no particular restrictions on, oil and gas development. (Leasing of oil and gas within incorporated city limits is prohibited by the Mineral Leasing Act of 1920.)

## STANDARD LEASE STIPULATIONS

The following lease stipulations have been developed by the Bureau of Land Management (BLM) and Geological Survey (GS). BLM must consult with GS before applying the first or third stipulation, but can use the others without consultation.

### Oil and Gas Lease Stipulations (to deal with specific situations)

1. All of the land in this lease is included in \_\_\_\_\_ (recreation or special area, etc.). Therefore, no occupancy or disturbance of the surface of the land described in this lease is authorized. The lessee, however, may exploit the oil and gas resources in this lease by directional drilling from sites outside this lease. If a proposed drilling site lies on land administered by the Bureau of Land Management, a permit for use of the site must be obtained from the Bureau of Land Management District Manager before drilling or other development begins.
2. No access or work trail or road, earth cut or fill, structure or other improvement, other than an active drilling rig, will be permitted if it can be viewed from the \_\_\_\_\_ (road, lake, river, etc.).
3. No occupancy or other activity on the surface of \_\_\_\_\_ (legal subdivision) is allowed under this lease.
4. No occupancy or other surface disturbance will be allowed within \_\_\_\_\_ feet of the \_\_\_\_\_ (road, trail, river, creek, canal, etc.). This distance may be modified when specifically approved in writing by the District Engineer, Geological Survey, with the concurrence of the District Manager, Bureau of Land Management.
5. No drilling or storage facilities will be allowed within \_\_\_\_\_ feet of \_\_\_\_\_ (live water, reservoir, etc.) located in \_\_\_\_\_ (legal subdivision). This distance may be modified when specifically approved in writing by the District Engineer, Geological Survey, with the concurrence of the District Manager, Bureau of Land Management.
6. No occupancy or other surface disturbance will be allowed on slopes in excess of \_\_\_\_\_ percent, without written permission from the District Engineer, Geological Survey, with the concurrence of the District Manager, Bureau of Land Management.
7. In order to \_\_\_\_\_ (minimize watershed damage, protect important wildlife habitat, etc.), exploration, drilling, and other development activity will be allowed only during the period from \_\_\_\_\_ to \_\_\_\_\_. This limitation does not apply to maintenance and operation of producing wells. Exceptions to this limitation in any year may be specifically



authorized in writing by the District Engineer, Geological Survey, with the concurrence of the District Manager, Bureau of Land Management.

8. In order to minimize watershed damage during muddy and/or wet periods, the District Manager, Bureau of Land Management, through the District Engineer, Geological Survey, may prohibit exploration, drilling or other development. This limitation does not apply to maintenance and operation of producing wells.

9. The \_\_\_\_\_ (trail/road) will not be used as an access road for activities on this lease.

10. To maintain esthetic values, all semipermanent and permanent facilities may require painting or camouflage to blend with the natural surroundings. The paint selection or method of camouflage will be subject to approval by the District Engineer, Geological Survey, with the concurrence of the District Manager, Bureau of Land Management.

The special "wilderness stipulation," which is attached to leases in the Gardner Mountain, North Fork Powder River, and Fortification Creek areas (see Map K), contains the following major provisions (BLM's Interim Management Policy and Guidelines For Lands Under Wilderness Review):

--Activities will be permitted under the lease as long as BLM determines they will not impair wilderness suitability.

--Activities must be temporary; their impacts must be reclaimable; and after reclamation is complete, the area's wilderness values must not have been degraded.

Use of this stipulation will continue until any or all of the areas listed above are eliminated from further consideration as wilderness.

## SOIL ASSOCIATIONS

Map E is a general soils map adapted from the Soil Conservation Service that shows the soil associations within the resource area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil and is named for the major soils. The soils in one association can occur in another, but in a different pattern.

The soil associations within the resource area have been grouped into six general kinds of landscapes for broad interpretive purposes. Each of the broad groups and the soils within each group are described below.

A- Areas Dominated by Nearly Level to Strongly Sloping Well-Drained Soils on Alluvial Fans

A-1 Cushman-Stoneham-Fort Collins. Moderately deep and deep, medium-textured soils on sideslopes and valley-filling fans. Included are Shingle, Thedalund, Razor, Absted and Petrie soils.

A-2 Ascalon-Fort Collins-Shingle. Deep, moderately fine-textured soils on valley-filling fans, and shallow medium-textured soils on ridges and steep hillsides. Included are Wold, Cragola, and Cushman soils.

F- Areas Dominated by Sloping to Steep Well-Drained Soils on Foothills

F-1 Wolf-Ascalon-Cragola. Shallow to deep, moderately fine-textured soils on old terraces and terrace margins, and deep, moderately fine-textured soils on sideslopes and valleys. Included are Cushman, Big Horn, Fort Collins, and Shingle soils.

F-2 Raynestord-Tropal-Aridic-Argiboralls: Shallow and deep, well-drained loam, clay loam, and gravelly soils on gently sloping and steeply sloping valley-filling fans and sideslopes and steeply sloping sideslopes. Bedrock is interbedded shales, sandstones, and siltstones.

F-3 Aridic-Argicstolls-Cragola: Shallow and deep, well-drained loam, clay loam, and gravelly soils on gently sloping and steeply sloping valley-filling fans and terrace escarpments. Bedrock is interbedded shales, sandstones, and gravels.

M- Areas Dominated by Sloping to Steep, Well-Drained and Excessively Drained Soils on Mountains

M-1 Hazton-Burgess-Mathers. Shallow and moderately deep, coarse and moderately fine-textured soils on open parks. Deep, moderately fine-textured soils on forested slopes. Included are Woodrock soils and rock outcrop.



M-2 Starman-Woosley-Decross. Shallow to deep, stony and moderately finetextured soils on rolling hills and valleys. Included are Nathrop, Amsden, and Witterhorn soils and rock outcrop.

M-3 Sunup-Passcreek-Rock Outcrop. Shallow and moderately deep, stony and moderately fine-textured soils interspersed with rock outcrop on sloping to steep slopes. Included are Simmont soils on forested slopes.

M-4 Woosley-Burgess-Decross. Shallow and deep, well-drained sandy loam and clay loam soils on sloping and extremely steep mountain slopes. Bedrock is limestone, dolomite, sandstone, and shales.

T- Areas Dominated by Gently Sloping and Sloping, Well-Drained Soils on Terraces

T-1 Big Horn-Wolf Variant-Ulm: Deep loam, clay loam, and clay soils on gently sloping terraces and valley-filling fans. Parent materials are derived from locally deposited sediments and gravel.

U- Areas Dominated by Gently Sloping to Very Steep, Well-Drained Soils on Uplands

U-1 Wyarno-Terry-Cushman: Moderately deep and deep clay loam, sandy loam and loam soils on gently to steeply sloping uplands. Bedrock is interbedded shales, siltstones, and sandstones.

U-2 Shingle-Rock Outcrop: Shallow, well-drained, medium-textured soil interspersed with rock outcrop on ridge crests and sidehill slopes, and incised by numerous gullies. Bedrock is sandstone or shale.

U-3 Renohill-Shingle-Stoneham: Shallow and deep loam, clay loam, and clay soils on gently sloping valley-filling fans and steeply sloping sideslopes. Bedrock is interbedded shales, siltstones, and sandstones.

U-4 Wibaux-Kirtley Variant-Rock Outcrop: Shallow, channery loam soils, and moderately deep, moderately fine-textured soils forming in porcelanite on ridges and hillsides interspersed with porcelanite outcrop. Included are Shingle, Thedalund, Kim, and Harlan variant soils.

U-5 Shingle-Wibaux-Rock Outcrop: Shallow, well- and somewhat excessively drained loam and channery loam soils on sloping to steep uplands intermingled with bedrock outcrop.

U-6 Briggsdale-Renohill-Pugsley: Moderately deep, well-drained loam, clay loam, and sandy loam soils on sloping to moderately steep uplands.

U-7 Olney-Maysdorf-Ulm: Deep, well-drained sandy loam and clay loam soils on nearly level alluvial fans and sloping to moderately steep uplands.

U-8 Shingle-Briggsdale-Cushman: Shallow and moderately deep, well-drained loamy soils on sloping to moderately steep uplands.

U-9 Shingle-Cushman-Bidman: Shallow, moderately deep, and deep, well-drained loamy soils on gently sloping alluvial fans and rolling to steep uplands.

U-10 Shingle-Thedalund-Kim: Shallow, moderately deep, and deep, well-drained loamy soils on rolling to steep uplands with deeply incised gullies.

U-11 Shingle-Fort Collins-Cushman: Shallow, moderately deep, and deep, well-drained loam soils on gently sloping alluvial fans and rolling to steep uplands.

U-12 Maysdorf-Bidman-Fort Collins: Deep, well-drained sandy loam and loam soils on gently sloping uplands.

U-13 Cushman-Bowbac-Fort Collins: Moderately deep and deep, well-drained loamy and sandy loam soils on rolling uplands.

U-14 Wibaux-Sear-Briggsdale: Shallow and moderately deep sandy loam and channery loam soils on steeply sloping sideslopes and ridges. Bedrock is interbedded shales, siltstones, sandstones, and porcelanite. Landslips are common in this area.

U-15 Wolf Variant-Shingle-Emmigrant: Shallow and moderately deep loam and clay loam soils on sloping and steeply sloping sideslopes and ridges. Bedrock is interbedded shales and gravels.

U-16 Samsil-Shingle-Rock Outcrop: Very shallow and shallow loam, clay loam, and clay soils on steeply sloping sideslopes. Rock outcrop is shales, porcelanite, and sandstones. Bedrock is interbedded shales, siltstones, sandstones and porcelanite.

U-17 Briggsdale-Renohill-Fort Collins: Moderately deep and deep, moderately fine and fine-textured soils on rolling uplands and sloping alluvial fans. Included are Shingle, Cushman, and Bidman soils.

U-18 Terry-Tassel-Fort Collins: Shallow to deep, moderately coarse to moderately fine-textured soils on ridges, sidehill slopes, and footslopes. Bedrock is sandstone.

U-19 Terry-Tassel-Shingle: Shallow and moderately deep, moderately coarse and medium-textured soils on ridges and sidehill slopes. Bedrock is sandstone or shale.



U-20 Moret-Kirtley-Rock Outcrop: Shallow, fine-textured soils on steep hillsides, and moderately deep, moderately fine-textured soils on sloping uplands, intermingled with rock outcrop. Included are Harlan, Absted, Rencalson, and Keyner soils.

U-21 Samsil-Gaynor-Rock Outcrop: Shallow and moderately deep, fine-textured soils on ridges and sidehill slopes, interspersed with rock outcrop. Included are Renohill, Petrie, and Wyarno soils.

U-22 Rock Outcrop-Spearfish: Shallow medium-textured soil interspersed in the rock outcrop on rough broken areas, canyons, and walls. Bedrock is siltstone.

U-23 Schooner-Gateson-Rock Outcrop: Shallow, coarse-textured soils interspersed with rock outcrop on ridges and canyons. Bedrock is sandstone.

V- Areas Dominated by Nearly Level to Gently Sloping, Well-Drained Soils on Floodplains and Alluvial Fans

V-1 Haverson-Glenberg-Bankard: Deep, coarse to moderately fine-textured soils on floodplains along major drainages.

V-2 Haverson-Bidman-Glenberg: Deep, well-drained, loamy and sandy soils on nearly level floodplains and very deep clayey soils on gently sloping alluvial fans.

V-3 Haverson-Lohmiller-Glenberg: Very deep, well-drained, loamy, clayey, and sandy soils on nearly level floodplains.

V-4 Barnum-Redbanks: Deep, moderately coarse and medium-textured soils on stream bottoms in the redbed areas.

PRECIPITATION/VEGETATION ZONES:  
KEY CLIMAX SPECIES AND OTHERS THAT INVADE

10" to 14" Northern Plains

|                        |                         |
|------------------------|-------------------------|
| Alkali bluegrass       | Sand bluestem           |
| Alkali cordgrass       | Sand dropseed           |
| Alkali sacaton         | Sandberg bluegrass      |
| Baltic rush            | Sideoats grama          |
| Basin wildrye          | Slender wheatgrass      |
| Bearded wheatgrass     | Spike sedge             |
| Big bluestem           | Stonyhills muhly        |
| Blue grama             | Switch grass            |
| Bluebunch wheatgrass   | Threadleaf sedge        |
| Bluejoint wheatgrass   | Tufted hairgrass        |
| Buffalo grass          |                         |
| Canada wildrye         | Various perennial herbs |
| Canby bluegrass        |                         |
| Cusick bluegrass       | Big sagebrush           |
| Green needlegrass      | Birdsfoot sagebrush     |
| Hairy grama            | Fourwing saltbush       |
| Indian ricegrass       | Gardners saltbush       |
| Inland saltgrass       | Greasewood              |
| Inland sedge           | Low rabbitbrush         |
| Little bluestem        | Rubber rabbitbrush      |
| Mat muhly              | Silver sagebrush        |
| Nebraska sedge         | Silverberry             |
| Needleandthread grass  | Skunkbush sumac         |
| Needleleaf sedge       | Snowberry               |
| Northern reedgrass     | Wildrose                |
| Nuttalls alkaligrass   | Winterfat               |
| Plains reedgrass       | Yucca                   |
| Prairie cordgrass      |                         |
| Prairie junegrass      | Conifers and junipers   |
| Prairie sandreed       | Cottonwood              |
| Red threeawn           | Willow                  |
| Rhizomatous wheatgrass |                         |

15" to 17" Northern Plains

All of the above with the exception of:

Basin wildrye  
Bluejoint wheatgrass  
Cusick bluegrass  
Northern reedgrass  
Birdsfoot sagebrush  
Silverberry



20" + High Mountains

Alpine timothy  
American mannagrass  
Baltic rush  
Basin wildrye  
Bearded wheatgrass  
Bentgrasses  
Big bluegrass  
Bluebunch wheatgrass  
Bluejoint reedgrass  
Blue wildrye  
Bottlebrush squirreltail  
California danthonia  
Canby bluegrass  
Columbia needlegrass  
Common reedgrass  
Cusick bluegrass  
Dunehead sedge  
Idaho fescue  
Inland sedge  
Lettermans needlegrass  
Mountain brome  
Mountain muhly  
Mutton bluegrass  
Nebraska sedge  
Nodding brome  
Northern reedgrass  
Onespike danthonia  
Oniongrass  
Prairie junegrass  
Pumpelly brome  
Redtop bentgrass  
Rhizomatous wheatgrass  
Richardson needlegrass

Sandberg bluegrass  
Slender wheatgrass  
Spike fescue  
Spike trisetum  
Sun sedge  
Sweetgrass  
Tall mannagrass  
Timber danthonia  
Tufted hairgrass  
Western needlegrass  
Williams needlegrass

Various perennial herbs

Big sagebrush  
Bitterbrush  
Black sagebrush  
Bog kalmia  
Chokecherry  
Conifers  
Limber pine  
Low rabbitbrush  
Low sagebrush  
Mountain mahogany  
Roses  
Rubber rabbitbrush  
Serviceberry  
Shrubby cinquefoil  
Silver buffaloberry  
Silver sagebrush  
Snowberry  
Snowbrush ceanothus  
Threetip sagebrush  
Water birch  
Willow

15" to 19" Northern Plains

Basin wildrye  
Bearded wheatgrass  
Big bluegrass  
Bluebunch wheatgrass  
Blue grama  
Blue wildrye  
Bluejoint reedgrass  
Canada wildrye  
Canby bluegrass  
Columbia needlegrass  
Cusick bluegrass  
Fowl bluegrass  
Green needlegrass  
Idaho fescue  
Indian ricegrass  
Lettermans needlegrass  
Little bluestem  
Mountain brome grass  
Mountain muhly  
Mutton bluegrass  
Nebraska sedge  
Needleandthread grass  
Nodding brome grass  
Northern reedgrass  
Onespike oatgrass  
Plains reedgrass  
Prairie cordgrass  
Prairie junegrass  
Prairie sandreed  
Pumpelly brome grass  
Red threeawn  
Rhizomatous wheatgrass  
Richardson needlegrass

Sandberg bluegrass  
Sand bluestem  
Sand dropseed  
Sideoats grama  
Slender wheatgrass  
Slouch sedge  
Spike fescue  
Spike sedge  
Spike trisetum  
Stonyhills muhly  
Threadleaf sedge  
Tufted hairgrass

Various perennial herbs

Big sagebrush  
Black sagebrush  
Boxelder  
Chokecherry  
Conifers  
Cudweed sagebrush  
Hawthorne  
Roses  
Rubber rabbitbrush  
Silver sagebrush  
Skunkbush sumac  
Snowberry  
Threetip sagebrush  
Wild plum  
Willow  
Winterfat



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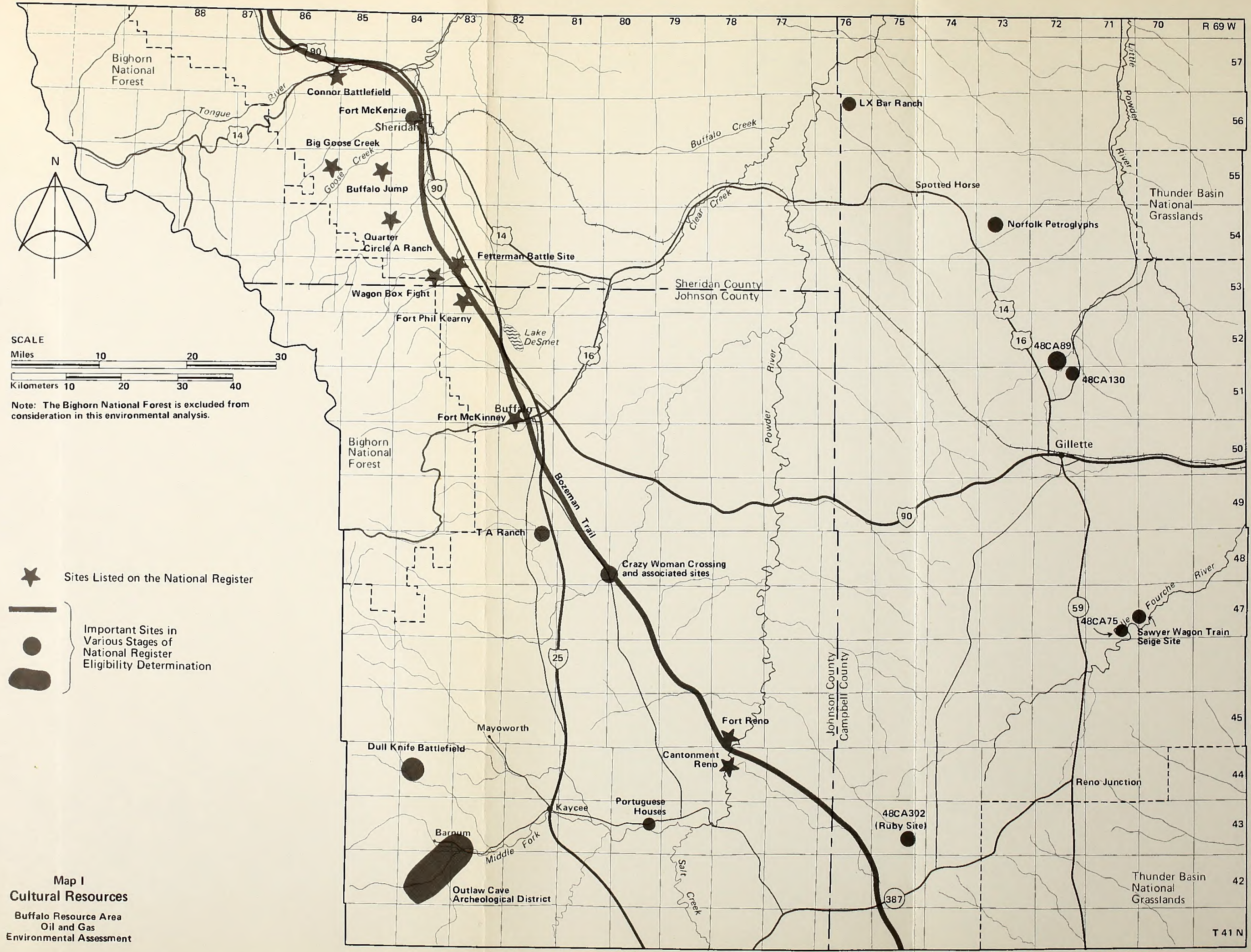
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SCALE  
Miles 10 20 30  
Kilometers 10 20 30 40

Note: The Bighorn National Forest is excluded from consideration in this environmental analysis.

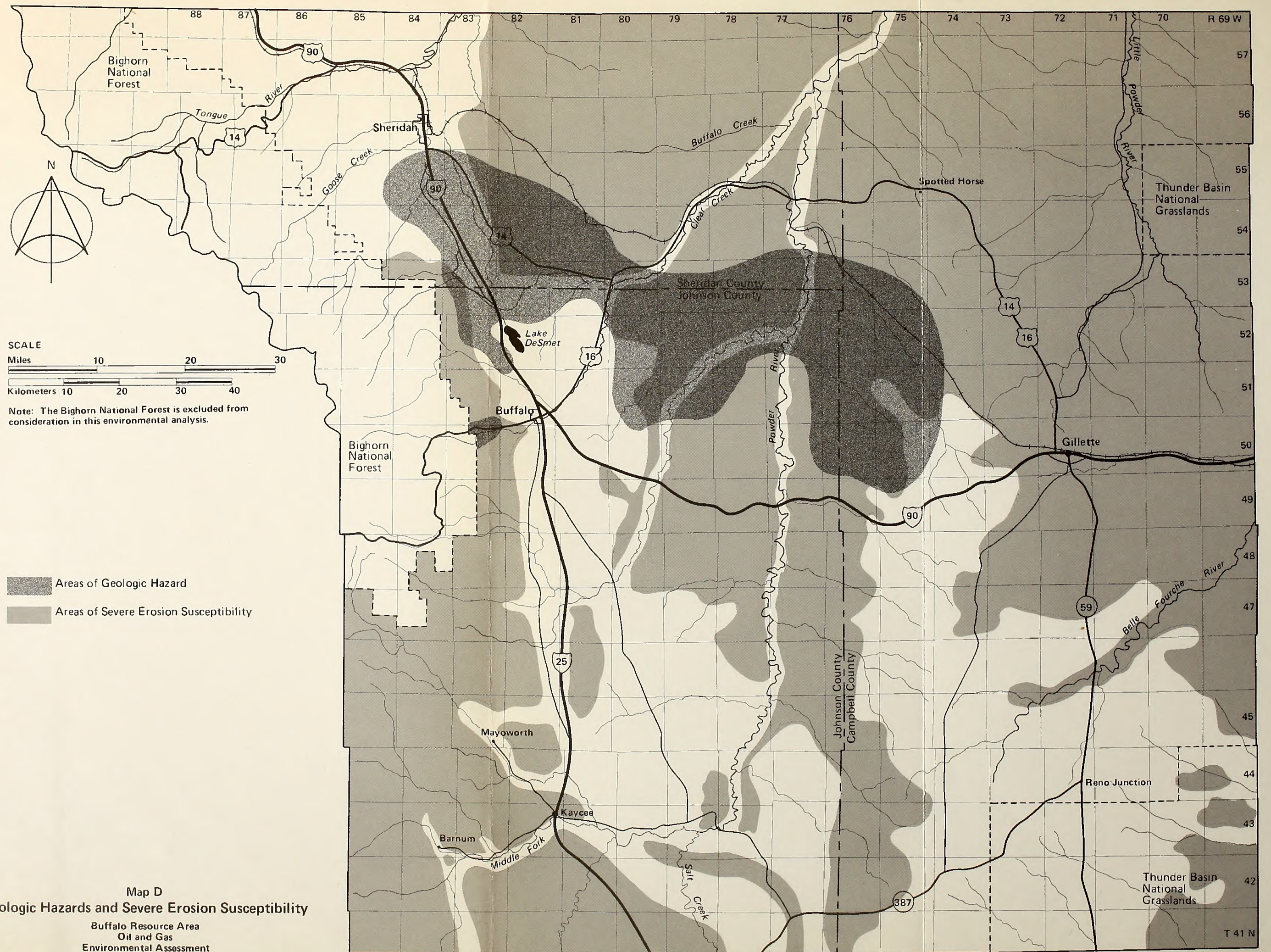
- ★ Sites Listed on the National Register
- Important Sites in Various Stages of National Register Eligibility Determination

Map I  
Cultural Resources  
Buffalo Resource Area  
Oil and Gas  
Environmental Assessment







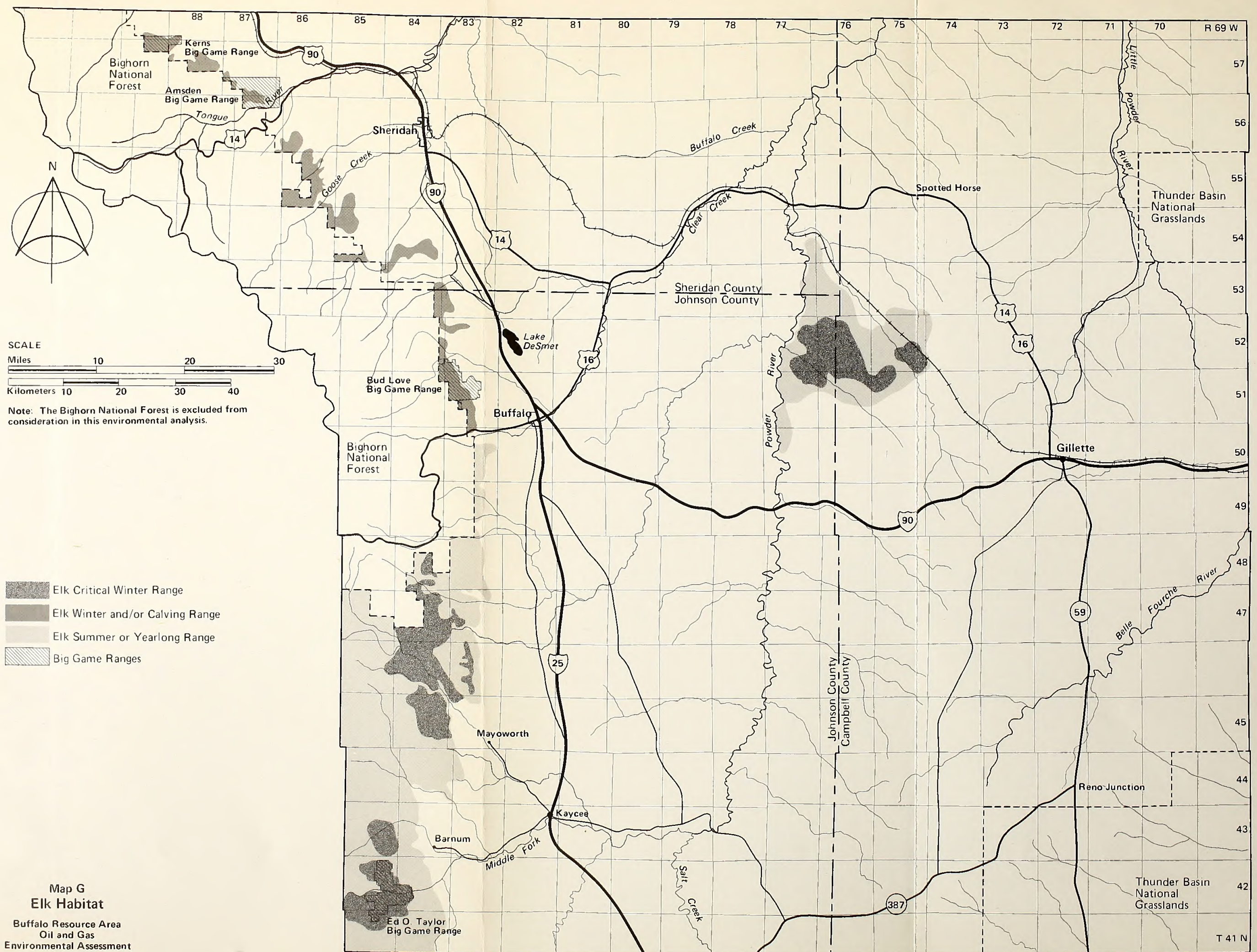


Map D  
Geologic Hazards and Severe Erosion Susceptibility  
Buffalo Resource Area  
Oil and Gas  
Environmental Assessment







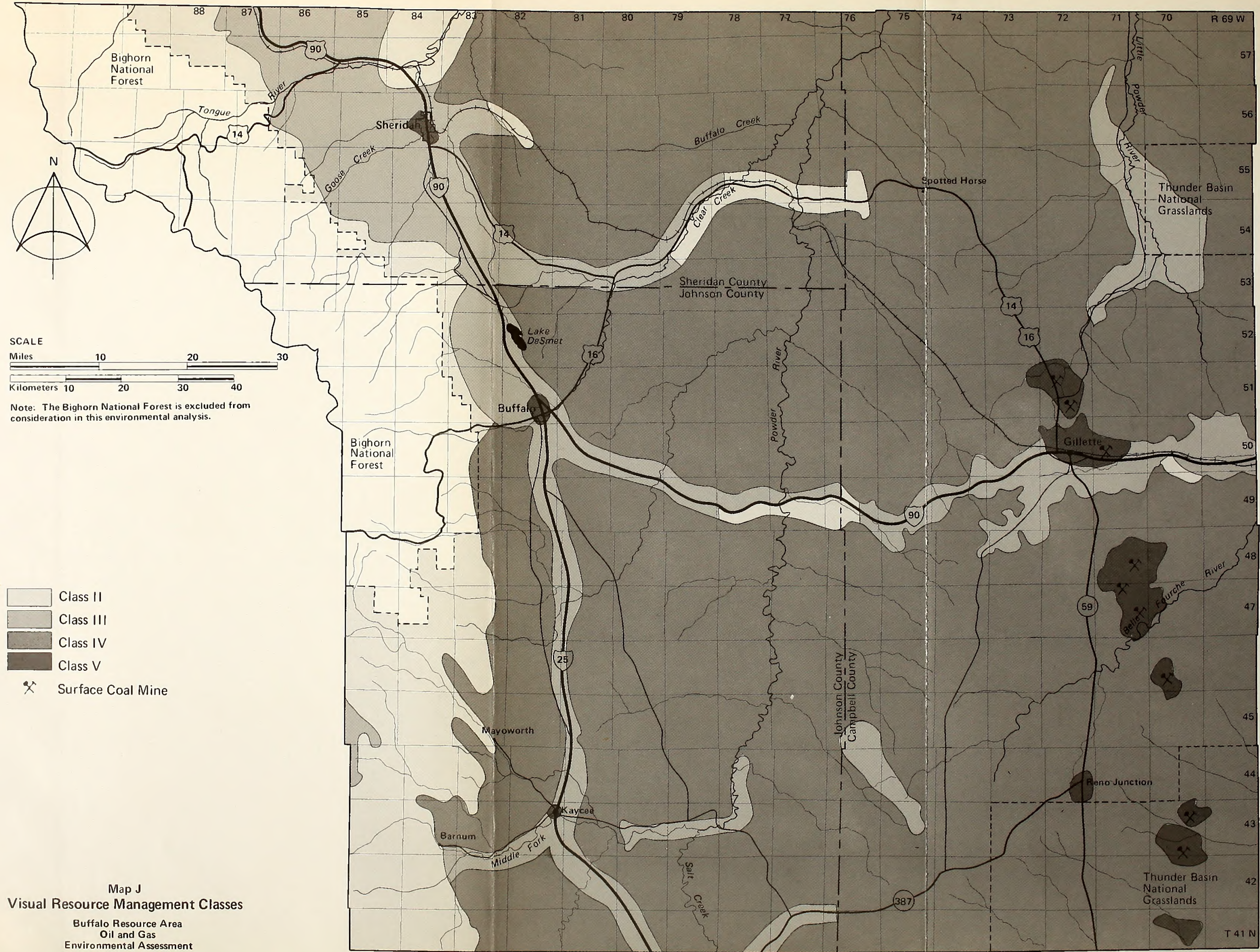


Map G  
Elk Habitat  
Buffalo Resource Area  
Oil and Gas  
Environmental Assessment









SCALE

Miles 10 20 30

Kilometers 10 20 30 40

Note: The Bighorn National Forest is excluded from consideration in this environmental analysis.

- Class II
- Class III
- Class IV
- Class V
- Surface Coal Mine

Map J

Visual Resource Management Classes

Buffalo Resource Area

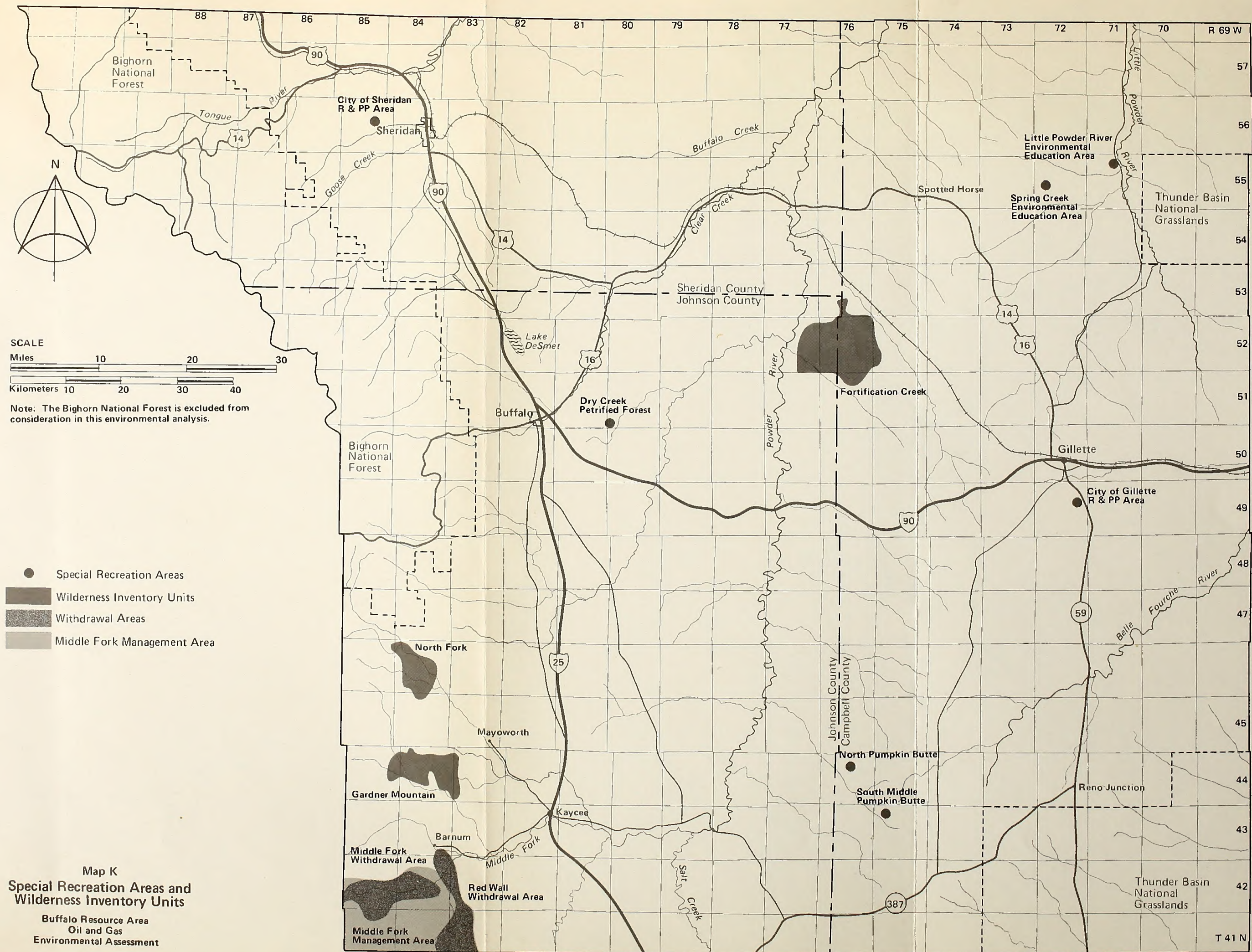
Oil and Gas

Environmental Assessment





















R'S CARD

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(Continued on reverse)

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Buffalo Resource Area oil  
and gas environmental

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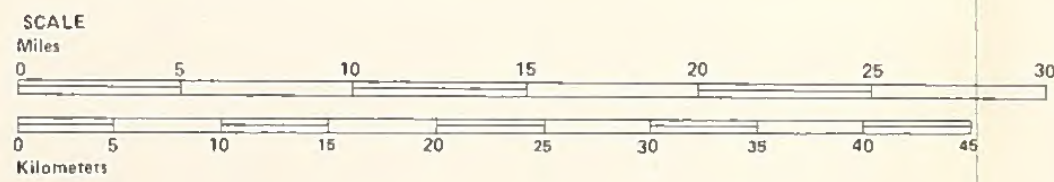








Note: The Bighorn National Forest is excluded from consideration in this environmental analysis.



Existing Oil and Gas Fields

# Map A Existing Oil and Gas Fields

Buffalo Resource Area  
Oil and Gas  
Environmental Assessment



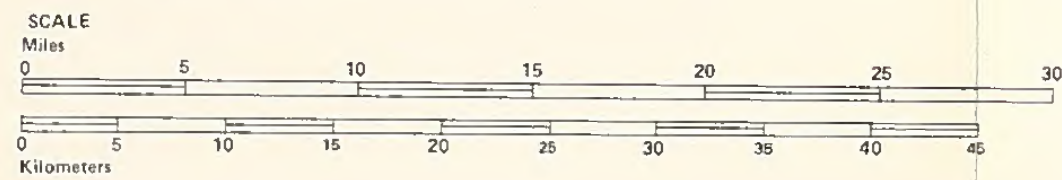








Note: The Bighorn National Forest is excluded from consideration in this environmental analysis.



(See Chapter 1, Description of Alternatives, Proposed Action)

- Slopes 25% or Greater, or Areas of Severe Erosion Hazard
- Middle Fork and Red Wall Special Management Area
- Fortification Creek Special Management Area Boundary
- No Surface Occupancy
- Historical or Archeological Site, Environmental Education Area
- Petrified Tree Area
- Big Game Range
- Bozeman Trail
- Sage Grouse Strutting Ground
- Sharp-tailed Grouse Dancing Ground
- Raptor Nest
- Areas Withdrawn From Mineral Leasing or Farther Than 1/2 Mile From a Place of Acceptable Occupancy
- Wilderness Inventory Unit (Wilderness Protection Stipulation)
- Reservoir

**Map B**  
**Oil and Gas Stipulations**  
Buffalo Resource Area  
Oil and Gas  
Environmental Assessment



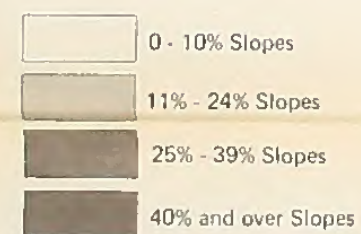
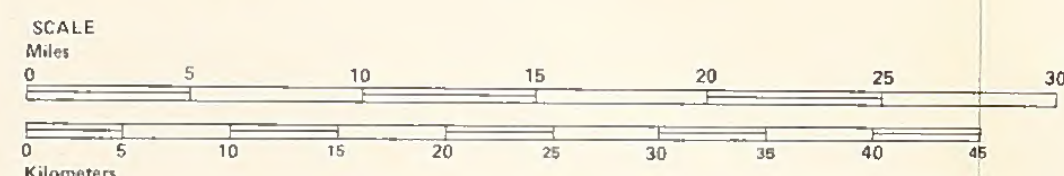








Note: The Bighorn National Forest is excluded from consideration in this environmental analysis.



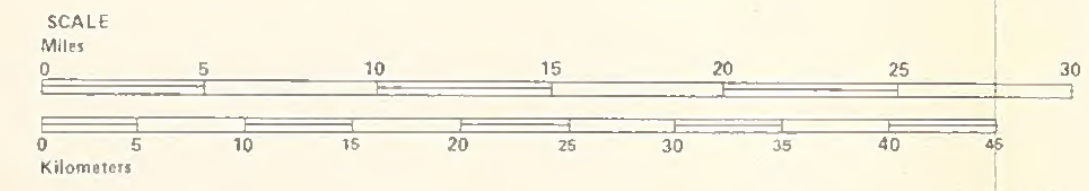








Note: The Bighorn National Forest is excluded from consideration in this environmental analysis.



- A** Soils on Alluvial Fans
  - A-1 Cushman-Stoneham-Fort Collins
  - A-2 Ascalon-Fort Collins-Shingle
- F** Soils on Foothills
  - F-1 Wolf-Ascalon-Cragola
  - F-2 Raynestord-Tropal-Aridic Argiborialis
  - F-3 Aridic Argicstolls-Cragola
- M** Soils on Mountains
  - M-1 Hazton-Burgess-Mathers
  - M-2 Starman-Woosley-Decross
  - M-3 Sunup-Passcreek Rock Outcrop
  - M-4 Woosley-Burgess-Decross
- T** Soils on Terraces
  - T-1 Big Horn-Wolf Variant-Ulm
- U** Soils on Uplands
  - U-1 Wyrno-Terry-Cushman
  - U-2 Shingle-Rock Outcrop
  - U-3 Renohill-Shingle-Stoneham
  - U-4 Wibaux-Kirtley Variant-Rock Outcrop
  - U-5 Shingle-Wibaux-Rock Outcrop
  - U-6 Briggsdale-Renohill-Pugsley
  - U-7 Olney-Maysdorf-Ulm
  - U-8 Shingle-Briggsdale-Cushman
  - U-9 Shingle-Cushman-Bidman
  - U-10 Shingle-Thedaland-Kim
  - U-11 Shingle-Fort Collins-Cushman
  - U-12 Maysdorf-Bidman-Fort Collins
  - U-13 Cushman-Bowbac-Fort Collins
  - U-14 Wibaux-Sear-Briggsdale
  - U-15 Wolf Variant-Shingle-Emmigrant
  - U-16 Samsil-Shingle-Rock Outcrop
  - U-17 Briggsdale-Renohill-Fort Collins
  - U-18 Terry-Tassel-Fort Collins
  - U-19 Terry-Tassel-Shingle
  - U-20 Moret-Kirtley-Rock Outcrop
  - U-21 Samsil-Gaynor-Rock Outcrop
  - U-22 Rock Outcrop-Spearfish
  - U-23 Schooner-Gateson-Rock Outcrop
- V** Soils on Floodplains and Alluvial Fans
  - V-1 Haverson-Glenberg-Bankard
  - V-2 Haverson-Bidman-Glenberg
  - V-3 Haverson-Lohmiller-Glenberg
  - V-4 Barnum-Redbanks



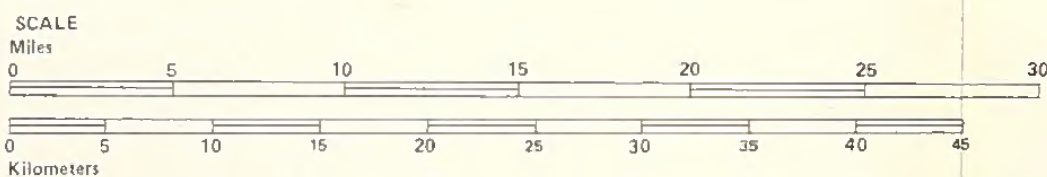




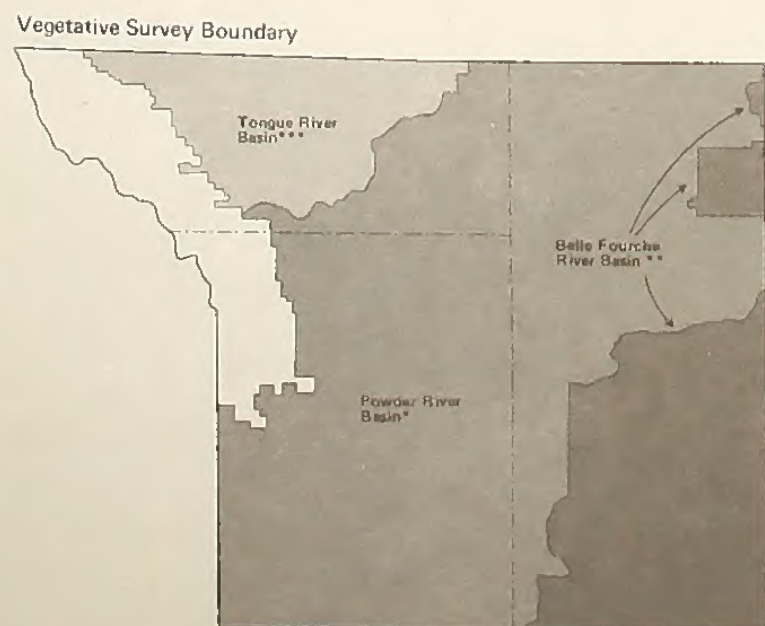




Note: The Bighorn National Forest is excluded from consideration in this environmental analysis.



- Grassland
- Cropland
- Sagebrush
- Broadleaf Trees
- Greasewood
- Conifers
- Waste - Rimrock, Steep Slopes
- Dense Timber
- Meadows
- Mountain Shrub
- Saltbush



\*Missouri River Basin Survey  
\*\*Information obtained from U.S.G.S. Land Use and Land Cover Maps  
\*\*\*Information not available except for scattered tracts

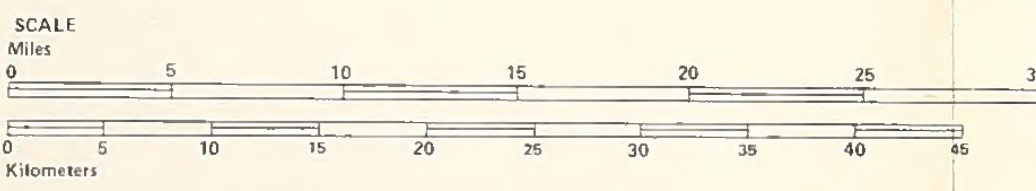








Note: The Bighorn National Forest is excluded from consideration in this environmental analysis.



- Sage Grouse Lek
- Sage Grouse Lek (Inactive in 1979)
- Sharp-Tailed Grouse Lek
- Raptor Nest
- Black-Footed Ferret Sighting Since 1970
- Prairie Dog Town
- Crucial Mountain Mahogany Stands

**Map H**  
**Special Wildlife Habitat**  
Buffalo Resource Area  
Oil and Gas  
Environmental Assessment









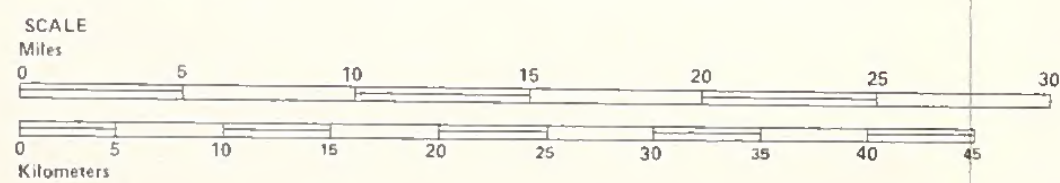








Note: The Bighorn National Forest is excluded from consideration in this environmental analysis.



Oil or Gas Pipelines (predominately major systems over 6 inches in diameter)

Major Transmission Lines

Power Distribution Lines

**Map M**  
**Transportation**  
**(Powerlines, Pipelines, Transmission Lines)**

Buffalo Resource Area  
Oil and Gas  
Environmental Assessment





